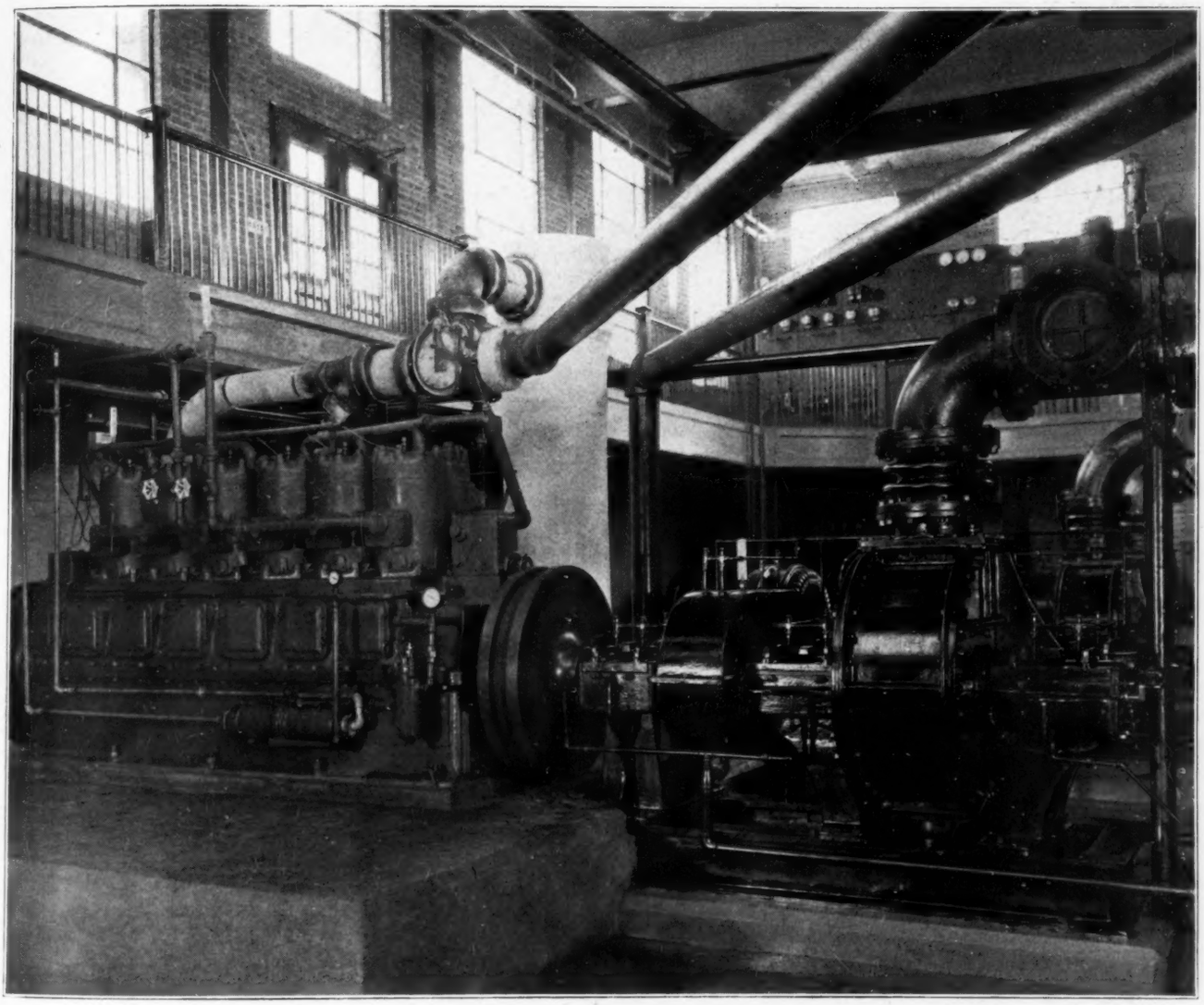
WATER WORKS AND SEWERAGE

May, 1933 — Editor — Vol. LXXX. No. 5



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WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

Malcolm Pirnie, Consulting Engineer of New York City and President-elect of the A. W. W. A., in a near future issue will discuss the subject of "Water Supply in Relation to City and Regional Planning."

Roger W. Esty, Superintendent of Water Works at Danvers, Mass., will recount interesting and unusual "Experiences in Locating Pipe Lines" with wireless pipe locator.

Darwin W. Townsend, Principal Assistant Engineer of the Sewage Commission of Milwaukee, is preparing two articles on "Screenings and Grit Incineration." A description of the new screenings incineration plant at Milwaukee will be presented. Later, experiences in operation and operating cost data will be revealed in a second article.

M. L. Crist, Consulting Engineer, Los Angeles, Calif., will present his idea on "The Proper Administration of Municipally Owned Water Utilities," based on experiences gained in dealings with this problem.

C. M. Roos, Manager of the Cairo Water Company, Cairo, Ill., will disclose methods used in "Financing and Operating Water Works During a Depression." The subject is timely if not pleasant.

Harry F. Ferguson, Chief Engineer of the Illinois State Department of Health, will tell of the revamping of the Downers Grove Sewage Treatment Works, wherein chlorination has been used for relieving bad stream conditions in lieu of the construction of additional new works for the present.

P. S. Wilson, Consultant in Water Works Operation, and formerly with the Community Service Company, will describe practical methods of making flow and pressure tests at fire hydrants and the value of securing such data.

Sheppard T. Powell, Consulting Chemical Engineer, of Baltimore, Md., will write a series of articles. The first one will cover "Water Supply Practice in Oil Refining Operations."

E. T. Cranch, Manager and Superintendent of the New Rochelle (N. Y.) Water Company, has submitted an article dealing with the practical side of "Hydrant Maintenance."

Robert B. Morse, Chief Engineer of the Washington Suburban Sanitary Districts, Hyattsville, Md., in the next issue will tell of the use of lightweight cast iron pipe in sewer construction. Permanency of structure, simplified construction, increased carrying capacity and other miscellaneous advantages are cited to justify the selection of cast iron pipe for the Washington suburban projects.

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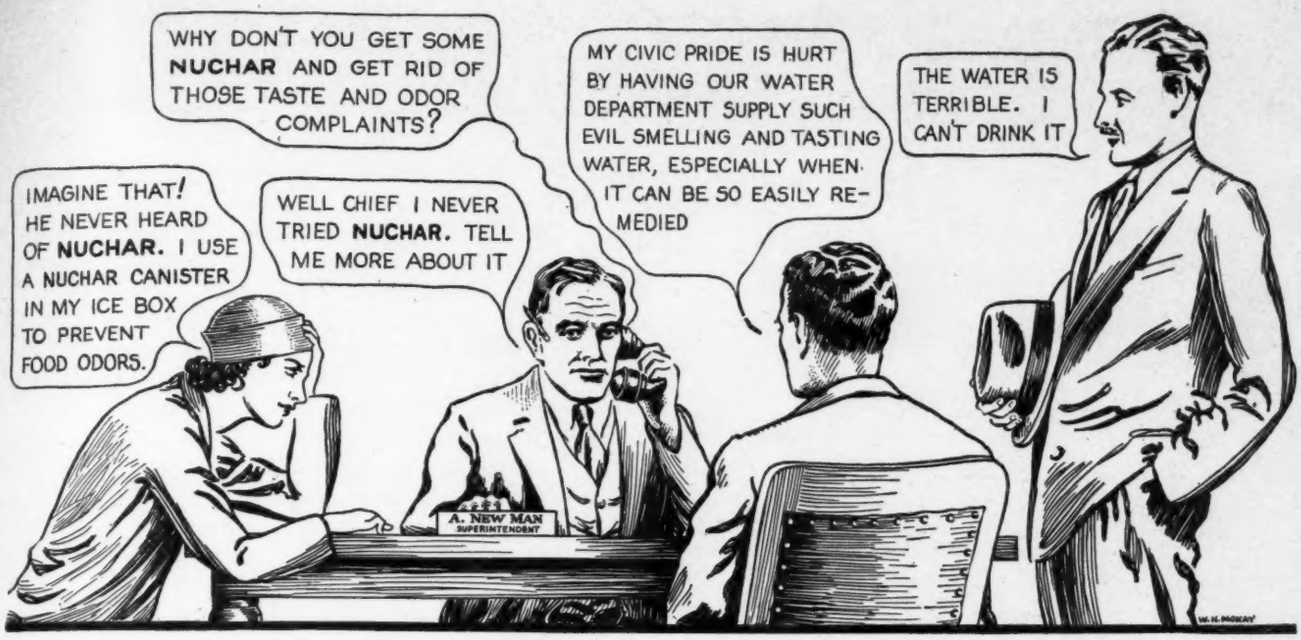
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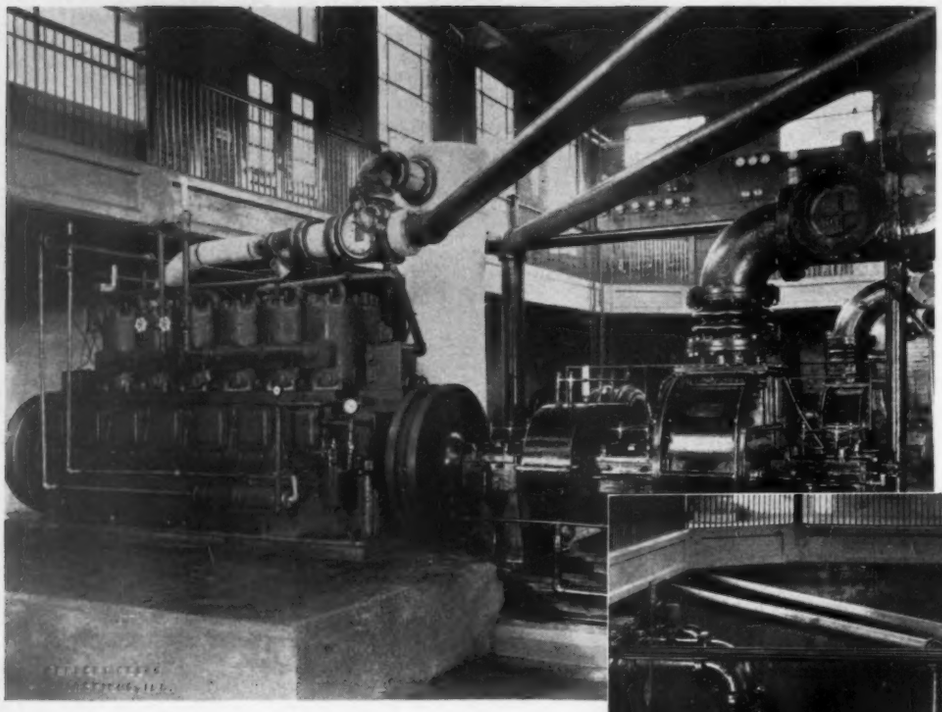
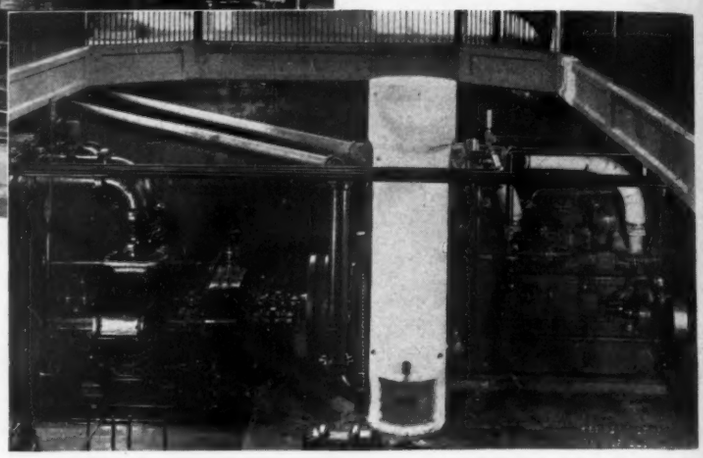


Clark Natural Gas Engine, installed in Sewage Works at Springfield, Ill.—the largest installation using sludge gas in America; 180-H.P. engine drives. blower delivering 3,300 cu. ft. of air per minute against 8.5 pounds' pressure.



Converting a by-product (sludge gas) into valuable power, this installation shows a gross yearly saving in electric current for air compression of $5,742, with a net saving, after deducting all annual charges, of $4,460.

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WATER WORKS AND SEWERAGE
MAY 1933
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POWER PRODUCTION FROM SLUDGE GAS AT SPRINGFIELD, ILL.

Waste Heat Utilized in Sludge Digestion

By W. B. WALRAVEN
District Engineer, Sanitary District of Springfield, Ill.

RECENTLY a gas engine and heat recovery units have been installed in the sewage treatment plant of the Springfield Sanitary District. In order to check the performance of the engine driving an air blower and the efficiency of heat recovery for the purpose of maintaining an elevated temperature in sludge digesters, a series of tests have been made. The results reveal the economy of using a gas engine powered with sewage sludge gas, and the advisability of utilizing the heat from the engine water jacket and the exhaust gases to heat the separate digestion tanks.

The scope of each test was limited to a study of factors of importance in sewage treatment practice. Five out of the six tests made, show surprisingly consistent results in all important respects. Omitting the most favorable test from consideration, the results indicate that 81.7 percent of the heat value of the gas was recovered either as useful work or went into the digestion tank heating system. Table I shows the distribution of the heating units, averaged for the five test runs.

TABLE I—HEAT BALANCE

Source	Percent of Heat Recovered
Returned as work	21.0
From engine water jacket	42.8
Recovered in exhaust heater	17.9
Total heat recovery	81.7
Radiation, friction and exhaust gas losses	18.3

The highest thermal efficiency from a gas engine, in terms of useful work produced, is about 25 percent.

Sewage Treatment Works of the Sanitary District of Springfield, Ill. In the Right Foreground Are Dorr and Link-Belt Clarifiers Operating Side by Side. Sludge Digesters Are on the Left.

This is predicated upon the condition that the engine will be run at full speed and load, and that there be only the normal back-pressure upon the engine exhaust. During the conduct of the tests the speed (305 to 420 r.p.m.) and load were in each case considerably below the designated capacities of the engine. We should there-

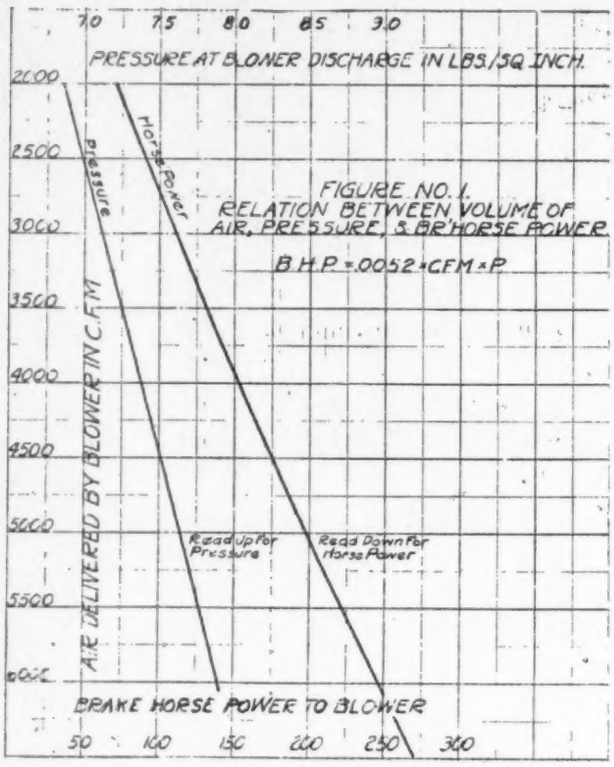


Fig. 1—Relation Between Volume of Air, Pressure and Brake Horsepower

fore automatically expect less than 25 percent of the fuel value of the gas to be transformed into useful work, the amount being governed largely by the mean effective pressure existing within the cylinders. Speed and load are factors directly affecting cylinder pressures.

The highest percentage of heat recovery from the engine water jacket reflects the high degree of efficiency in the functioning of the cooling system, and shows, moreover, that we might have cooled the engine sufficiently well for good operating conditions with a smaller quantity of water circulated.

Units Tested

The Springfield Sanitary District purchased a vertical gas engine from the Clark Bros. Company, of Olean, N. Y. The engine has 6 cylinders (9x11 in.), rated at 177 indicated horse-power at 514 r.p.m., with 65 pounds of mean effective pressure. This unit drives a Connersville, positive-displacement-direct connected blower, designed to deliver 3,300 cu. ft. of air per minute against a discharge pressure of 8.5 pounds per square inch. The engine cooling water and the exhaust gases pass through a No. 5 Paracoil heater. Circulation is provided by centrifugal pumps which force the water through the water-jacket to the Paracoil heater and thence through heating coils within the sludge digestion tank, where the excess heat is absorbed, before the water returns to the engine.

Determination of Work

Prior to the purchase of the gas engine, the Connersville blower was electrically driven. Extensive tests were made on this blower and also upon two other similar units at the sewage treatment plant, to determine the power consumed in compressing different volumes of air under varying pressures. One curve in Fig. 1 shows the relationship existing between the rate of air delivery and the pressure set up in the air lines. The other shows the relationship existing between the rate of air delivery and the brake horse power delivered at the blower shaft. The motor efficiency was assumed to be 90 percent, this figure being supplied by the General Electric Company.

The two curves follow straight lines so closely that no appreciable error results from the use of the equation.

$$\text{Brake Horse Power} = .0052 \times \text{CFM} \times \text{P}$$

In fact, we were informed by representatives of the Connersville Blower Company that their power guarantees follow more nearly the formula

$$\text{B.H.P.} = .0054 \times \text{CFM} \times \text{P}$$

However, since our observations on the performance of the blower were conducted over a long period, and since the formula first given was less favorable in rating the gas engine, we used the data determined experimentally by us.

Engine Capacity

Figure No. 2 gives a comparison between the power required to operate the blower at different speeds, and the ability of the engine to furnish that power. As before stated, the maximum allowable mean effective cylinder pressure was set at 65 pounds per square inch. It will be seen that the power characteristics of the engine lie above and parallel to the blower power characteristics. As a matter of fact, this was perhaps the most important single factor governing the selection of the engine. Since the motors on the two electrically

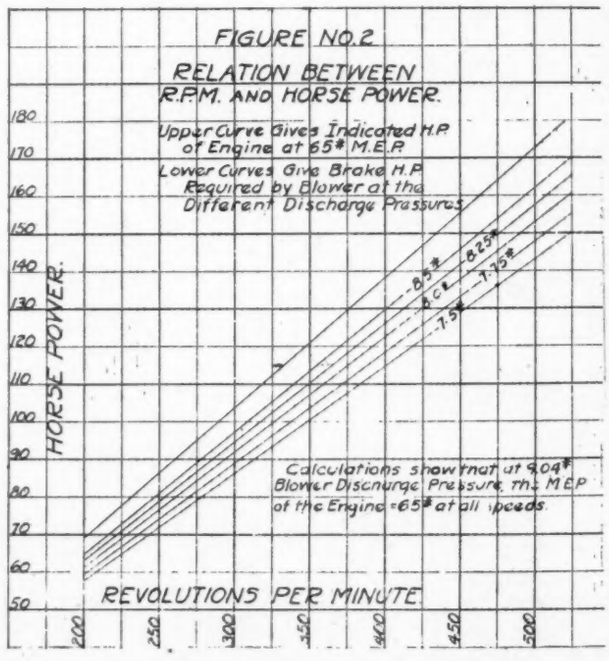
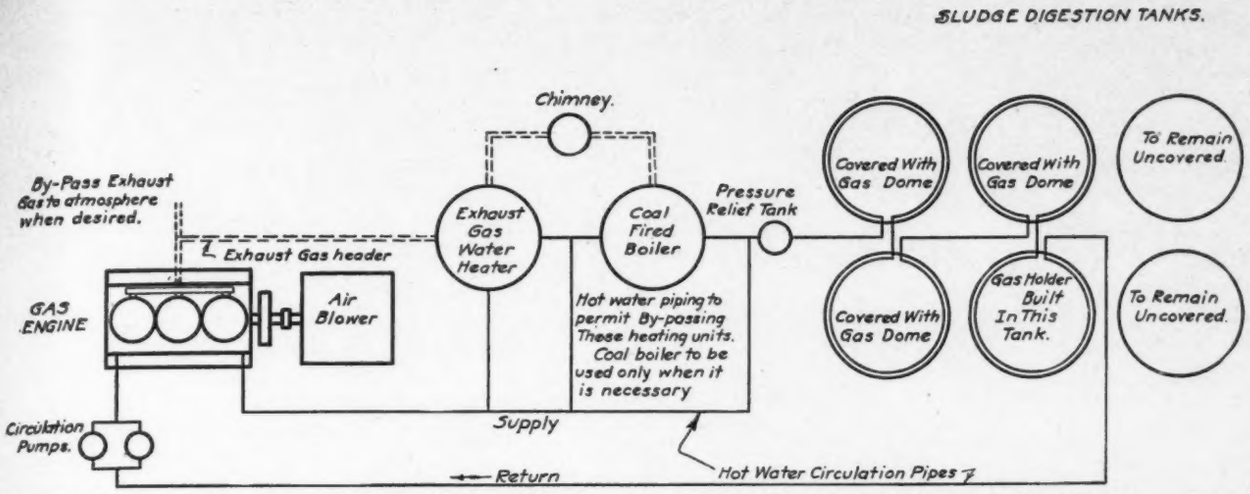


Fig. 2—Relation Between R.P.M. and Horsepower

driven blowers will reach maximum capacity when the discharge pressure reaches 8.5 lbs. per square inch, the gas engine is regarded as having ample power capacity.

Heat Units in Gas

Inasmuch as the engine tests were conducted on different days, it was found necessary to determine the heat content of the gas during each test. As was expected, the value of the gas varied considerably, ranging from a minimum of 533 up to a maximum of 627 B.t.u. per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Pressure Relief Tank
Covered With Gas Dome
Covered With Gas Dome
To Remain Uncovered.
GAS ENGINE
Air Blower
Hot water piping to permit By-passing These heating units. Coal boiler to be used only when it is necessary
Covered With Gas Dome
Gas Holder Built In This Tank.
To Remain Uncovered.
Circulation Pumps.
Supply
Return
Hot Water Circulation Pipes

Diagram Showing System for Utilization of Waste Heat from Gas Engine Recently Installed at Springfield Sewage Treatment Plant

cubic foot. C. C. Larson, Chemist of the Springfield plant, reported the average of two gas analyses each day. In determining the heat content, the percentage of each constituent gas present was reported. We used in all cases the "lower or net" heating values, in conformity with the practice outlined in S. W. Parr's text "Fuel, Gas, Water and Lubricants."

In analyzing the guarantees received from six of the leading makers of large gas engines we found an absolutely unanimous agreement that the "lower or net" values should be used rather than the "gross" value. As a matter of interest, an actual gas analysis is given in Table II, with the B.t.u. per cubic foot figured both on the "lower" and on the "gross" values.

TABLE II—COMPARISON OF NET AND GROSS HEATING VALUES

Constituent Gas	Percent	(A) B.t.u. on "Lower Value"	(B) B.t.u. on "Gross Value"	B.t.u. per cubic foot of mixture based on (A)	B.t.u. per cubic foot of mixture based on (B)
Carbon Dioxide	32.6	....	....	....	....
Methane	64.3	908.5	1009.0	584.2	648.8
Hydrogen	1.4	271.8	326.2	3.8	4.6
Nitrogen	1.7	....	....	....	....
Oxygen	0.0	....	....	....	....
Carbon Monoxide	0.0	....	....	....	....
Calculated Heat Values	0.0	....	....	588.0	653.4

From the table it is obvious that in order to arrive at any true comparison, B.t.u. values reported should state whether the "lower" or the "gross" values are assumed. Since the "lower" value is nothing more than the "gross" value corrected for the heating value of the water vapor formed during the explosion, and since the gas engine cannot possibly recover the heat of the water vapor down to S. C. at 60° F., and 30 inches of mercury, it appears logical for engine makers to adopt the lower fuel value as standard.

Instruments Used During Tests

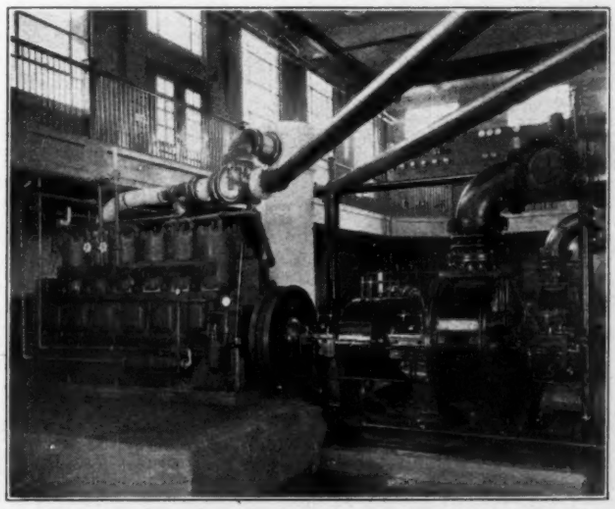
The Connersville blower is an accurate air meter, provided the revolutions per minute are determined and the volume per revolution is corrected for slip at the pressure existing. During the conduct of the tests the speed of rotation was checked closely by long time observations, using a speed counter mounted on the blower shaft. Since the blower is direct-connected to the engine drive shaft, the engine and blower must travel at identical speeds. The pressure of the air at the blower discharge was measured several times during each test by means of a mercury manometer. In no case did the readings vary by as much as one tenth of an inch of mercury during any test run. The speed of the engine was perfectly controlled by an automatic governor which proved to be extremely sensitive and accurate.

The volume of water circulated was measured by a Worthington hot water meter. Observations taken several times during each test proved that the rate of recirculation by the pumps was quite constant. The volume of gas flowing was measured through a Connersville gas meter. Temperatures were read on three thermometers, one mounted on the water line as it enters the engine water jacket, a second on the water line between the engine and the Paracoil, and a third on the line after the water had passed through the heater.

In the calculations for the heat absorbed in the engine water jacket and in the heater, we assumed that water weighs 8.33 pounds per gallon, and that a B.t.u. is equal to the amount of heat required to raise the temperature of one pound of water 1° F. at any temperature.

Tabulation of Results

Table III gives a summary of the more important items of information collected during the test. As mentioned previously, we cannot give complete credence to



New 177 H.P. Gas Engine Installation at Springfield, Ill., Sewage Treatment Works, Direct Connected to Blower, Delivery 3,300 C.F.M. of Air Under 8.5 Lbs. Pressure to Aeration Tanks

the results shown for test No. 2 because we assumed that the quality of the gas had not changed from that found for test No. 1 on the preceding day. However, the results are shown if only for the purpose of illustrating the futility of drawing conclusions without first having determined all variables in a test run.

TABLE III—TEST RUNS ON GAS ENGINE*

Test No.	3	4	1	2	6	5
Rev. per min....	305	307	327	385	390	420
Cu. ft. of air per min.	2,240	2,250	2,400	2,820	2,860	3,080
Blower discharge pressure, lb./sq. in.	7.47	7.47	7.56	7.77	7.71	7.77
Brake horsepower to blower shaft	87.0	87.7	94.5	114.1	115.0	124.7
B.t.u. of gas on day of test—net value	627	613	533	533	613	613
B.t.u. required per brake horsepower	11,850	12,450	12,200	11,300	12,100	12,100
Temperature of water entering water jacket...	106	104	83.5	97.0	110	99.5
Temperature of water leaving engine	135	135	118.5	135.5	145	139
Temperature of water leaving exhaust heater.	146	146	130	150	165	158.5
Gals. of water circulated per min.	30.9	31.1	30.6	30.5	31.0	31.2
Million B.t.u. of gas used in 24 hours	24.7	26.5	27.6	31.0	35.0	36.4
Heat recovered as work (%)....	21.5	20.4	20.9	22.4	21.0	21.0
Heat recovered by engine water jacket (%)...	43.5	44.3	46.8	46.1	38.9	40.6
Heat recovered by exhaust gas heater (%)...	16.5	15.7	15.2	17.1	22.2	20.1
Total heat recovered and used (%)	81.5	80.4	82.9	85.6	82.1	81.7
Total B.t.u. put into water per Br. hp. per day.	170,500	179,000	181,000	171,500	178,000	177,000
Million B.t.u. put into water in 24 hours	14.8	15.7	17.1	19.6	20.4	22.1

*Clark 6 cylinder (9 in. x 11 in.) Vertical, driving Connersville blower.

Table IV gives calculations made for the purpose of arriving at a figure representing the gross annual savings which may possibly result from the installation of the gas engine and other incidental equipment. Net savings can be determined only by applying a factor to represent the percentage of time during which the units will be in actual service, and thereafter deducting items for interest, depreciation, and operation charges.

To the Springfield Sanitary District, the most important single item in Table IV is the figure for the annual saving in power with the engine running at 307 r.p.m., which is the speed at which we shall operate most of the time. With the engine running at that speed, 24 hours a day, the saving in current will amount to $6,380 per annum with a gas supply averaging 44,200 cubic feet per day for the year. This figure should nearly be realized in practice.

The table also indicates that the annual value of the water jacket and exhaust gas heat will amount to $1,320. This being of interest to us, does not represent a true saving because we were formerly using the gas under our boilers to as great or probably somewhat greater extent. It is evident that in utilizing sludge gas to produce power, the waste heat should be put to use when there is a need for the heat around the plant, particularly at the digestion tanks. With coal at higher prices than at Springfield, the saving from this source would be proportionately greater.

TABLE IV—TEST RUNS ON GAS ENGINE CONTINUED

Test No.	3	4	1	2	6	5
Rev. per min....	305	307	327	385	390	420
Cu. ft. of air per min.	2,240	2,250	2,400	2,820	2,860	3,080
Brake horsepower to blower shaft	87.0	87.7	94.5	114.1	115.0	124.7
Daily saving in k.w.h. over motor drive at 90% efficiency	1,730	1,745	1,880	2,275	2,290	2,480
Annual saving in elec. current at elec. rate of 1c per kwh.	$6,320	$6,380	$6,860	$8,300	$8,350	$9,060
Daily cost of coal at $3 per ton and 10,000 B. t.u./lb. to give equivalent heat salvaged Furnace at 65% eff.	$3.42	$3.63	$3.95	$4.53	$4.71	$5.11
Annual value of engine heat salvaged figured as above	$1,250	$1,320	$1,440	$1,650	$1,720	$1,860
Gross value annually of gas as work & heat	$7,570	$7,700	$8,300	$9,950	$10,070	$10,920
Daily flow of gas in cu. ft. at 600 net value to give equiv. results..	41,200	44,200	45,800	51,600	58,300	60,600

Cost of Power Development

In a discussion of costs, it is not easy to separate those items which should definitely be charged against the gas engine and those which should be charged against the sewage treatment plant construction program. For example, our recent construction program included among other items, a new floating steel gas collector on Tank No. 5 and a gas holder on Tank No. 6, together with heating coils in each. Concerning the advisability of covering and heating these two tanks from the standpoint of increasing treatment plant efficiency, there should be no question. At the time of initial construction in 1928, the plans called for the covering of four tanks, but due to the shrinkage of the Sanitary District's tax income, it was considered advisable to delay the installation of two covers until some later date. We have found during the past month that tank No. 6, covered with the gas holder can be and is being used for the digestion of sludge in the same manner as No. 5, and as a matter of fact, better than the first tanks, No. 1 and No. 2, because the heating coils in the older tanks are not adequate to maintain the sludge at the proper temperature. We are now increasing the capacity of the coils in tanks No. 1 and No. 2 by 300 per cent to bring them up to a parity with No. 5 and No. 6.

Table V shows the cost of the recent improvement, subdivided into its component parts.

If it can fairly be said that the covering and heating of the two digestion tanks should be a charge against the general treatment plant, then the Gas Engine Power Development cost the Sanitary District $7,475. If the heating and covering of the two tanks are not considered as essential to the plant as a whole, then the power development should be charged with an additional $8,260, bringing the total to $15,735. In arriving at annual charges, figures have been set up using both costs.

TABLE V—CONSTRUCTION COSTS

Item	Amount
Gas engine and piping	$5,705
Air starting equipment	288
Exhaust heater	520
Engine base	270
Installation	300
Insulation of boiler, etc	32
2 Gas boosters	250
Gas governing equipment	110
Total for engine	$7,475
Gas holder—23,000 cu. ft	3,365
Floating cover	3,588
Heating coils	1,300
Total for digestion tanks	$8,260

Basis for Annual Charges

In determining the annual charges, an attempt has been made to arrive at figures approximately as closely as possible the conditions applicable to the Springfield Sanitary District. The several items used, together with a brief discussion of each, are given below:

(a) Interest is figured at 4½ per cent per annum. We can and do borrow on long term bonds at that figure.

(b) Since the engine will not be running all the time, we have set the load factor at 90 per cent, believing that we shall certainly equal or better that performance.

(c) Depreciation is figured complete in fifteen years, requiring a sinking fund rate of .04811 per annum, although as a matter of fact the units should have some resale or useful value far beyond a period of fifteen years.

(d) Total Brake Horse Power Hours per annum were figured from Table No. 3. With the engine running at 307 r.p.m., and with a load factor of 90 per cent the engine will develop $87.7 \times 24 \times 365 \times 0.90 =$ 692,000 B. H. P. Hr. per annum.

(e) Lubricating oil costs us 50c per gallon, and at the figures for the guaranteed performance of the Clark engine, should give at least 3,000 B. H. P. Hr. per gallon.

(f) Spare parts and maintenance are figured at $1.15 per B. H. P. per year by most of the companies using similar equipment.

(g) It is difficult to figure in advance the cost of labor to run the gas engine. Up to date it has been almost negligible and in general, I am confident that we can keep the engine going without calling for help outside of our regular force. The companies using similar equipment customarily use .62c per B. H. P. per month, or as in our case $87.7 \times \$0.62 = \$54.40$ per month. This includes the salaries of the men who do nothing but keep a battery of engines running, and in our opinion does not apply to the conditions at our treatment plant. To arrive at a figure we have assumed that the labor of maintaining the engine will not exceed seven man hours a week, or 365 hours a year, at $0.65 per hour or $237.00 per annum.

(h) Water and miscellaneous items such as rag waste are usually figured at $0.15 per B. H. P. per month, which would amount to $87.7 \times \$0.15 \times 12 \times 0.90 =$ $142.00 per annum. This seems rather high, but since we have no data upon which to base a contradiction, we will allow that figure.

Annual Charges

(A) Based Upon Total Cost.

Using the figures above noted, and charging the entire improvement against the gas engine, the Table VI shows the annual charges, which cover all the usual conditions encountered with equipment similar to that which we have installed.

TABLE VI—ANNUAL CHARGES AGAINST COMPLETE DEVELOPMENT

Item	Extension	Annual Charges
1. Interest	$15,735 @ 4½% =	$ 708
2. Depreciation complete in 15 years	$15,735 @ 4.811% =	757
3. Lubricating oil	692,000 × $0.50 / 3,000 =	115
4. Spare parts and maintenance	87.7 × $1.15 × 90% Factor =	92
5. Labor of attendance	365 hours @ $0.65 =	237
6. Water and miscellaneous	87.7 × $0.15 × 12 × 90 =	142
Total Annual Charges		$2,051

If it is conceded that the general operation of the plant is bettered by the addition of the two covers and the heating coils, and that we should have built them in 1928 along with the first general construction program, the annual charges against the gas engine should be reduced as shown in Table VII.

TABLE VII—ANNUAL CHARGES AGAINST THE ENGINE DEVELOPMENT ALONE

Item	Extension	Annual Charges
1. Interest	$7,475 @ 4½% =	$ 336
2. Depreciation (15 years)	$7,475 @ 4.811% =	360
3. Other items (3 to 6) in Table No. 6		586
Total Annual Charges		$1,282

Net Annual Saving

From Table III it may be seen that with the engine running at 307 r.p.m., for 100 per cent of the time, the saving in electric current would amount to $6,380 per annum, but we have assumed that the engine will be idle for an average of one hour in each ten. Under that assumption, the saving in current would be reduced to $5,742. Table VIII shows the two conditions in condensed form under which the net annual value of the gas engine installation may be computed.

TABLE VIII—NET ANNUAL SAVING

Condition	Annual Saving in Electric Current	Annual Charges (See Tables 6 & 7)	Net Annual Saving	Interest on Investment*
Charging engine with all cost of development, $15,735	$5,742	$2,051	$3,691	27.9%
Charging engine with only $7,475	5,742	1,282	4,460	64.2%

*Since the annual charges include 4½% interest, this amount is added to the column "Per cent interest on investment."

Under the most unfavorable conditions, charging the power production with the entire cost of development, and giving it no credit for the heat put into the water, seems to be rather a severe rule with which to measure the return realized on the investment. On the other hand, there is merit to the possible contention that perhaps we could have gotten along without covering and heating tanks No. 5 and No. 6. Somewhere between these two limits will be found the true percentage which may be realized from the investment.

It would appear from the above figures that almost irrespective of the conditions assumed, the investment will prove to have been wisely made. No one can predict with accuracy what will happen within the next four years, but if the engine holds out for even that short length of time, we shall not have lost any money. For every year the engine runs beyond four, and for every year the new floating cover and gas holder are in use beyond that time, the savings will appear as "pure velvet."

Charging the entire expenditure against the engine and depreciating the entire equipment 100 per cent in four years, the net saving will be $770.00 per year.

It is not difficult to show large savings with a gas engine when the fuel is obtained free.

Amount of Gas Required

With the engine running at 307 r.p.m. the gas required per day will be about 44,200 cu. ft. at 600 B.t.u. (see Table IV), but we have set up our figures on the basis that the engine will be idle one hour in ten. Such a program therefore requires nine-tenths of 44,200 cu. ft., or 39,800 cu. ft. of gas per day. This is about the amount of gas we have used for three and one-half years before covering tanks No. 5 and No. 6. With four tanks covered instead of two the gas supply will be ample.

Conclusions

We do not pretend to know what the actual saving will be, but we do know a few things for certain. Under carefully observed conditions, we know that when the engine was running at 307 r.p.m., using sewage sludge gas, it drove our blower which compressed 2,250 cu. ft. of air per minute against a discharge pressure of 7.47 lb. per square inch and that we put 15,700,000 B.t.u. of heat into sludge heating coils per day. We know that the total volume of gas used per day was 42,720 cu. ft. (for 24 hours service), the gas having 613 B.t.u., "lower" heating value. We know also that at different speeds and loads the work done and the heat salvaged were in direct proportion to the amount of gas used. Knowing these things to be true, we are willing to leave the more speculative elements for a future answer. Regardless of the ultimate answer we know that the engine is proving a good investment regardless of the method of keeping books.

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New Incinerator of Baltimore, Md.

The city of Baltimore with a present population of approximately 825,000, enters 1933 with the completion of a refuse incinerator of 600 tons per 24 hour capacity. This plant was built on city owned property on Reed Bird Ave. near Hanover St. The 1932 report of the Bureau of Sanitary of the Maryland State Department of Health gives the following details regarding the new plant:

The structure was completed after Baltimore city had advertised for bids for the collection and disposal of rubbish and garbage. The successful bidder was required to give bond in the amount of the estimated cost of the entire plant, plus the further sum of $100,000. The total bond amounted to about $525,000. After completion and approval of the plant the penalty of the bond is to be reduced to $250,000.

Bids were requested on three items, as follows:

a. A price per ton for collecting and hauling all the rubbish to locations as directed.

b. A price per ton for evaporation, incineration and disposal of that portion of the rubbish ordered diverted to the garbage incinerator.

c. A price per ton for evaporation, incineration and disposal of the garbage at the garbage incinerator.

A court suit instituted by certain taxpayers residing in the vicinity of the proposed plant was decided by the Circuit Court of Baltimore city in favor of the city on all points. This decision was ratified by the Court of Appeals of Maryland.

Bids under the new incinerator plan were opened by the Board of Awards of Baltimore city on June 15, 1932, and the contract was awarded on July 13, 1932. Construction work on the 600 ton per 24 hour plant was started July 21, 1932. Rubbish was burned in the plant on December 21, 1932, and garbage on January 1, 1933. The plant was built by the contractor at an initial cost of about $700 per ton per 24 hours.

The annual cost under the old and new plans of reduction and incineration, respectively, and the annual savings, are shown in the following data:

Item	Dollars-Cost per Ton Old	New	Saving	Tons of Material	Total Annual Saving, Dollars
(a) Collection of Rubbish	5.75	4.10	1.65	120,000	198,000
(b) Incineration of Rubbish....	1.40*	0.80	0.60	44,000	26,400
(c) Disposal of Garbage	3.10**	1.85***	1.25	80,000	100,000
					324,400

* Includes only net cost of plant operation.
** Does not include excess cost of $1.00 in 1932.
*** Includes the cost and amortization of plant in ten years.

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Powell Made Chairman of 4 States Section of A. W. W. A.

At the spring meeting of the 4 States Section of the American Water Works Association, held April 27th and 28th in Washington, D. C., Sheppard T. Powell, Consulting Chemical Engineer of Baltimore, Md., was elected chairman. The new chairman is well known in the water works field for his important committee work in the A. W. W. A. and other societies—and for his prowess in the field of industrial water supply particularly. Formerly in charge of purification plants operated by the Baltimore Suburban Water Company, he later became associated with the Engineering Division of the Maryland Department of Health prior to taking up consulting practice. He has also been active in industrial waste problems, recently having been named chairman of a Joint Committee on Stream Pollution composed of members of the American Society of Civil Engineers and the American Institute of Chemical Engineers.

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Water Works and Sewerage Project in Ohio

In a radio broadcast on April 29, Mr. F. H. Waring, Chief Sanitary Engineer, Ohio State Department of Health, gave the following outline of the present situation in respect to water supplies and sewerage and sewage disposal:

It is estimated that in a normal year the amount of construction of new works or improvements to existing works for the sanitation of Ohio cities and villages will amount to approximately $15,000,000, as represented by plans submitted to the Department for approval. In 1930, however, the work approved amounted to $12,000,000, in 1931 to $8,000,000 and in 1932 to less than $3,000,000. In connection with these figures some rather surprising facts have been developed as to the need for public water and sewage works.

Acording to reliable estimates compiled by the Department there are nearly $40,000,000 worth of such improvements that have been deferred, apparently in a mistaken belief that the present is not the proper time to execute the work. This work is scattered among 63 Ohio municipalities, of which 34 need waterworks improvements to cost $27,000,000 and 31 need sewerage and sewage treatment improvements estimated to cost $13,000,000. These figures include the $14,000,000 worth in 36 municipalties in which plans, specifications and estimates have been completed, or nearly so.

THE AMMONIA-CHLORINE PROCESS AT RICHMOND

Overcoming Difficulties and Reasons for Use

By MARSDEN C. SMITH

Engineer, Bureau of Water and Electricity, Richmond, Va.

Marsden C. Smith

THE ammonia-chlorine process as used in municipal water supplies has received a great deal of attention during recent years. However, the idea of using the two chemicals in water purification plants is not new. As long ago as 1904 its use was suggested. However, for many years the treatment of drinking water supplies by this method received but little attention. Unfortunately, perhaps, when interest was again revived, many chemists and plant operators were over enthusiastic in their beliefs as to its uses and properties. Many were quick to believe that the ultimate in sterilization and taste and odor elimination had been found. Fortunately, the keen interest aroused, by the successful application in many plants, has by this time developed a more rational evaluation of its true merit, both in taste and odor control and as a sterilizing agent.

Two Applications of Process

Briefly, it seems today that the ammonia-chlorine process has two separate and distinct applications. One the control of taste and odor; the other prolonged sterilization. When chemicals, particularly phenols, which combine with or are acted upon by chlorine to produce a greatly amplified taste or odor are present, ammonia added with or before the chlorine often prevents this increase in taste. In most cases this is probably due to the greater affinity of chlorine for ammonia than for the disturbing chemical; and the chloramine being virtually tasteless, the formation of such mal-tasting chlorous compounds is avoided. Here it is generally necessary to use an excess amount of ammonia over the theoretical requirements to make certain that as much as possible of the chlorine will combine with the ammonia rather than with the taste producing chemicals. However, where chemicals or oils of various organic substances are present, for which chlorine has an affinity more nearly approaching that for ammonia, or which have taste and odor not materially affected by the addition of chlorine, then but little taste and odor improvement results from the use of ammonia. In other words, the ability of the process to remove or prevent taste and odor in drinking waters is limited.

However, where prolonged sterilization, such as for the protection of reservoirs or distribution systems is needed, the ammonia-chlorine process seems universally adaptable. Perhaps its most valuable feature is that while its sterilizing value equals or exceeds the equivalent chlorine, higher residuals may be used with no apparent ill effects; and its action persists vastly longer than the very active chemical, chlorine.

Experiences with Chloramines at Richmond

The experiences in the use of chloramines at Richmond have proven of such interest that they are given here in hope that they may prove helpful to others contemplating their use. In August, 1930, the first plan scale experiments were inaugurated. The ammonia was then added to the incoming untreated water about 10 minutes before the addition of the chlorine. Prechlorination in an amount of from 12 to 15 pounds per million gallons had been used for some time prior to this experiment, mainly to assist coagulation; however, even this quantity of chlorine had been completely dissipated in the first few feet of travel of the water in the coagulated water settling basins. The ammonia was added at the rate of from 6 to 8½ pounds per million gallons, and almost as fast as the water moved through the basins, the residual chloramines, as determined by the orthotolocine reaction, persisted through the basins and onto the filters. Rapidly the residual on the filters increased to 1½ parts per million; but even this quantity was entirely dissipated in the filters and none appeared in the filter effluent. It was known that the filters were at that time heavily loaded with organic growths and materials, but the chlorine demand of these materials was astonishing. It was seven hours before any trace was found in the filter effluent; but, when it appeared, the accompanying odors were beyond description and the taste was nauseating, vile and, in fact, terrible.

Fortunately it was possible to supply the city from the reservoir and waste this mal-odorous compound coming from the filters. After three or four hours the worst of this was over, and the filter effluent greatly improved, indicating a cleaning of the filter beds that was very beneficial in other ways. The removed materials that had so seriously clogged the filters, defying all efforts to remove by straight chlorination or other means, had so limited filter runs that the capacity of the plant had been reduced to a very dangerous point. This condition was immediately improved as is shown by the increase of more than 71 per cent in the average filter runs. Since this experience, we have systematically used chloramines to purge the filters when runs become unduly short because of organic loading, and this, with complete success. Of course this purging is done with the filter effluent connected to the sewer through the rewash because of the severe taste and odors always produced by this cleaning. In view of the fact that this clogging of the filter beds occurs when the demands for water are at the maximum, such an effective, simple and inexpensive means of maintaining filter capacity, is certainly of tremendous value.

However, this difficulty encountered in the introduction of the process was by no means the end. Some of the mains in Richmond have been in continuous service a great many years, and during this time, mud, organic and other materials had accumulated in them. When the residual chlorine, persisting so much longer than ever before because of the ammonia-chlorine treatment

reached out into the distribution system, tastes and odors became almost intolerable. This alone was sufficient reason to discontinue the process, but another and more serious difficulty arose.

When a rapid sand filter receives a water that is deficient in preparation for filtration, either the filtering rate must be reduced to approach the behavior of the slow sand type, or the filter efficiency reduced, or perhaps, both. At the time of these experiments, the mechanical treatment of the water after the application of the coagulant, had not been installed; and the water was frequently very poorly prepared for filtration. To compensate for this deficiency in preparation, it was necessary to operate the filters with as heavy coatings as possible. When the chloramines had penetrated and cleaned the filter sand, the assistance of this coating was lost, and the filter effluent became entirely unsatisfactory. It was, therefore, further necessary to abandon the use of chloramines, if formed before filtration.

The repeated confirmed presence of B. Coli in the open reservoir, the absence of any protection against infection in the distribution system and the frequent "dead-end" complaints, demanded attention and action.

There are some investigators who report that sterilization, particularly in waters having a relatively high pH, is slower when the ammonia-chlorine process is used than when chlorine alone is the sterilizing chemical. While this opinion is not by any means universal, since some consumers were quite close to the Richmond plant, it was deemed unwise to rely on the chloramine sterilization if applied after filtration. Fortunately, prechlorination in more than sufficient quantity to furnish a sterilized water to the filters was known to materially assist coagulation. It, therefore, became economical to rely upon this prechlorination for sterilization, and safely form the chloramines after filtration for the much desired protection beyond the filter plant.

It than remained a problem how to introduce the process without the obnoxious taste and odors being formed in the distribution system. This was very successfully solved by a method that we have not found reported. Post chlorination had been used for years in sufficient quantity to give a "trace" residual at the low pressure pumping station. It was decided to start by adding only 1 pound of ammonia to the daily output of 22 million gallons of water; which is the very small amout of four one-hundredths of 1 pound per million gallons. Seven employes of the department were selected so as to have a trained observer in each section of the city to report any taste or odor that might occur. At about two day intervals the amount of ammonia added was increased slightly, or, to be exact, four-tenths of a pound per day, until the orthotolodine indicated residual at the plant effluent increased. The chlorine applied was then reduced as the ammonia was increased, holding the same residual, until the approximately theoretical ratio of 3 pounds of chlorine to 1 pound of ammonia was reached. Then, maintaining this ratio, the residual at the plant effluent was gradually increased at intervals of several days until the desired residual in the system was obtained. The results were splendid and in only one very limited area was there any complaint by consumers, and this for only one day. A residual of four-tenths of a part per million is the maximum at any service tap deemed advisable. However, this limit is sufficient to produce a residual throughout practically the entire distribution system.

The process has been in full operation since May 12th of 1932, and so, we can now report certain operating experiences and studies which we hope will prove interesting.

The first problem, after the introduction, was to determine the most effective ratio of ammonia to chlorine. Since the purpose here was to prolong the time of effective sterilization, and since the unit cost of ammonia is greater than the unit cost of chlorine, it was important to determine the ratio that would produce the desired time-residual results with the minimum cost of the two chemicals. Experiments have indicated that, for most of the time, a ratio of one part (by weight) of ammonia to two and one-half parts of chlorine is the most effective ratio for this purpose. In other plants this ratio may not obtain, as the relative cost of the chemicals and the water quality may be quite different from these factors at Richmond.

Then, the most successful source of the necessary ammonia required careful consideration. Please note that the word "successful" is here used with the intention of pointing out that there is more involved than the matter of cost. It seems that plant operators are being tempted more and more to reduce operating costs by the use of chemicals, which while well suited for an industrial process are quite undesirable for use in a public water supply. Ammonium sulphate, the cheapest source, is produced mainly as a fertilizer. The usual by-product quality was found upon analysis to be quite unsuited; and, so anhydrous ammonia, available in iron drums, was used. This is undoubtedly the most convenient, pure and pleasant source of ammonia. Since the equipment to control the application of the anhydrous ammonia was installed, a synthetic ammonium sulphate has become available that is of sufficient purity to render its use both successful and economical. It would have been adopted at Richmond except for the fact that other considerations make it more economical to retain, for the present, the use of anhydrous ammonia.

But little effort has been made since the first tests to determine the effectiveness of this process in the control of tastes and odors, as we are certain that other means are here much better suited for this purpose.

The benefits that may be attributed to its use may be summarized as follows:

(1) An effective means of maintaining filter capacity.
(2) The elimination of B. coli in the reservoir.
(3) The protection of the distribution against accidental pollution.
(4) A reduction of more than eighty per cent in the number of dead-end complaints.

These benefits have been obtained with no ill effects, except that we have observed a rather luxuriant moss growth in the basins. This is certainly not plankton, and produces no more serious condition than an unattractive appearance. We presume, but have not confirmed, that this growth has been assisted by the presence of the ammonia-chlorine compounds. But even though this suspicion is confirmed, it is indeed a small price to pay for the benefits that have resulted from the use of the ammonia-chlorine process.

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New Water Supplies for New York Villages

Trumansburg, in Tompkins County, at a recent election voted to issue $89,000 in bonds for the development of a water supply and the construction of a distribution system.

On March 31, the taxpayers of Otego, Otsego County, voted favorably upon a proposition to issue $13,000 in bonds for a new water supply from wells.

The village of Sherman, Chautauqua County, has put into use a new water supply derived from a drilled well.

NEW ACTIVATED SLUDGE TREATMENT PLANT NEWARK, N. Y.

By GLENN D. HOLMES

Consulting Engineer,
Syracuse, N. Y.

Glen D. Holmes

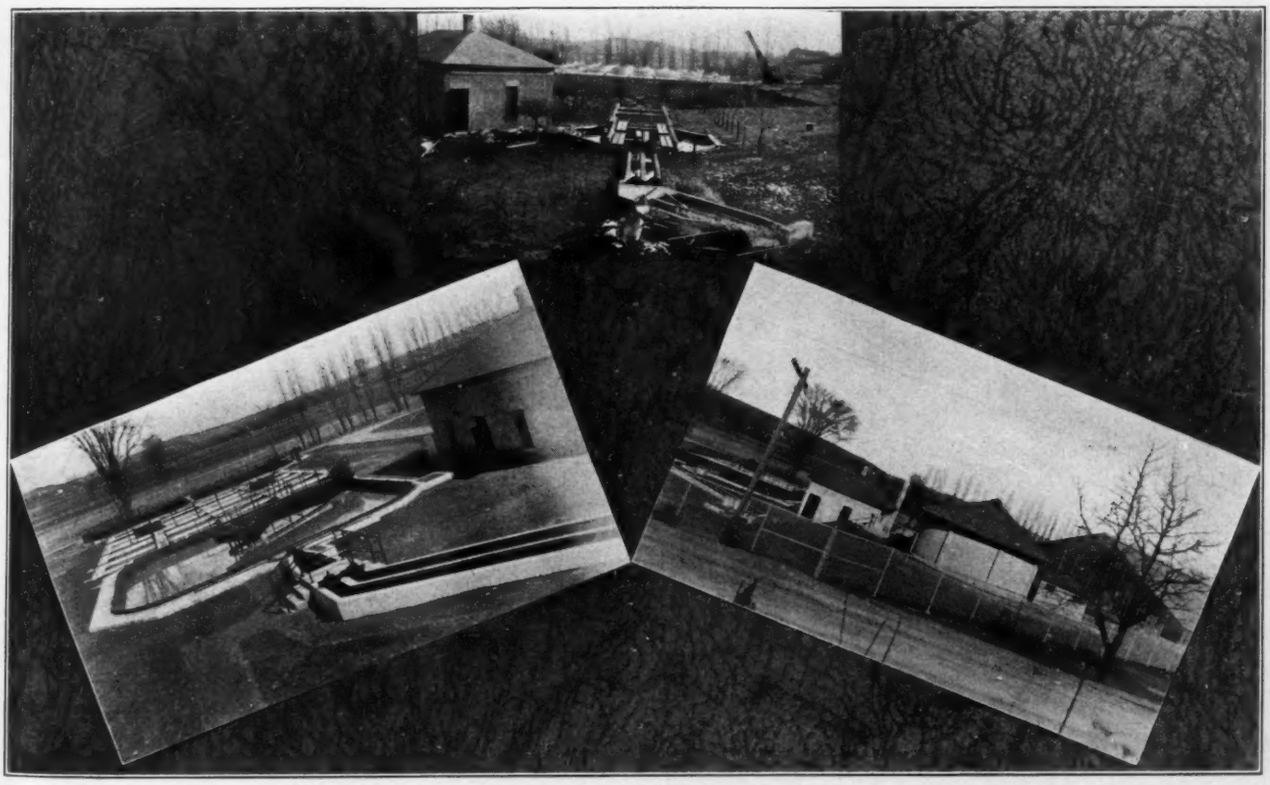
NEWARK, N. Y., an enterprising village of 7,500 people, is located within a rich farming and fruit country, on the main line of the New York Central Railroad about 30 miles easterly from Rochester, N. Y. The State School for Feeble Minded contributes a large portion of the total sewage flow. Although the manufacturing establishments contribute a comparatively small quantity of industrial waste, the sewage reaching the treatment works is of more than average strength.

The Old Plant

The village constructed a separate system of sewers and a treatment plant in 1914. A few street inlets have since been connected, which add substantially to the sewage flow during times of heavy rainfall. Infiltration adds a further burden during seasons of high ground water table.

The old plant included a screen and grit chamber, a radial flow Imhoff tank, open sludge drying beds, a pumping station, sprinkling filters, and final settling tank. Motor driven centrifugal pumps, in duplicate, with automatic control, discharged the Imhoff tank effluent to an elevated dosing tank. The same equipment was used for pumping sludge from the tank to the drying beds.

Military Run, a tributary of Ganargua Creek, received the plant effluent. A few years after placing the plant in service, the state of New York diverted the greater part of the flow of Military Run to the Barge Canal, which left insufficient water in the stream for satisfactory dilution. During later years all units of the plant were of inadequate capacity. The flowing-through compartment of the Imhoff tank provided insufficient time for detention, and the suspended solids which escaped clogged the filters and caused pooling. The lower compartment of the Imhoff tank provided too little space for digestion and it was necessary to draw undigested sludge to the drying-beds. A golf course adjoins two sides of the plant with a putting green within less than 100



Upper: The Old Newark Plant—Screen Chamber in Foreground Followed by Double Compartment Grit Chamber and Radial Flow Imhoff Tank. The Sprinkling Filter in the Background is Operating at Maximum Head—Note the Poor Distribution. The Elevated Dosing Tank May Be Seen at Left of Filter Behind the Pumping Station. Left: The New Newark Plant—The Grit Chamber in the Foreground Is Followed by Venturi Flume, Primary Clarifier, Aeration Tanks and Final Clarifiers. Trees at Rear Are on Line of Golf Club Grounds. Right: General View of New Newark Plant. Treatment Tanks Are o n Left, Pumping Station, Gas Holder, Digester House and Glass-Enclosed Sludge Drying Beds Are in Order to Right.

ft. of the noisome open sludge drying beds. Several dwellings are in the neighborhood. Serious odors, which at times were carried for a considerable distance, were the cause of many complaints, and it became necessary to abate the nuisance.

Selection of Process for Reconstruction

Consideration was first given to enlargement of the existing plant to provide for adequate treatment. A study was also made of the practicability of revamping the plant for the activated sludge process. Construction and operating costs were found to compare favorably, particularly for the reason that a gravity flow could be obtained through an activated sludge plant while pumping of sewage was required for sprinkling filters. It was realized that the activated sludge process would necessitate more careful, intelligent supervision, but this was believed an advantage, since it would insure the employment of more experienced and competent operators.

The New Plant

All of the units of the old plant, with the exception of the grit chambers and sludge drying beds were utilized advantageously in reducing the cost of the new treatment works. The alterations and new construction required in connection with the revamping of the old plant for the activated sludge process may be briefly summarized as follows:

1. A new bar screen with closer spacing.
2. A new grit chamber of more efficient design.
3. A venturi flume and sewage meter.
4. A primary clarification tank with mechanism for sludge removal.
5. Two aeration tanks of the paddle wheel, diffused air type.
6. Two final clarification tanks with sludge removal mechanisms.
7. Alteration of the old imhoff tank for controlled separate sludge digestion.
8. A new, controlled, separate sludge digestion tank.
9. Alteration of the existing final settling tank for sludge storage and conditioning.
10. Alteration of the sprinkling filters to glass enclosed sludge drying beds.
11. Alteration of the old pumping station for the new mechanical equipment and for laboratory and office use.
12. Construction of a gas holder.
13. Installation of equipment for the utilization of the gas from digestion, and for supplying air for aeration of the sewage.
14. Installation of laboratory equipment for routine analysis.
15. Grading and landscaping of the grounds, installation of flood lights for night illumination, and the erection of a fence around the plant site.

The plant was designed for a future population of 10,000, and an average sewage flow of 1.5 million gallons per day. All sewage including storm flows will pass through the primary settling tank, a maximum of 2.25 m.g.d. will be given activated sludge treatment. Flows in excess of this maximum may be diverted to the outlet sewer after primary clarification.

The more important factors of the basic design, may be summarized as shown in Table I.

TABLE I

Seasonal Flow	Sewage Flow m. g.d. Present	Sewage Flow m. g.d. Future	Detention Period—Hours* Prim. & Final Clarifiers Present	Prim. & Final Clarifiers Future	Aeration Tanks Present	Aeration Tanks Future	Cu. Ft. Air per Gal. Present	Cu. Ft. Air per Gal. Future
Summer average..	0.85	1.10	3.5	2.73	8.85	6.82	0.61	0.47
Spring average...	1.25	1.50	2.4	2.00	6.00	5.00	0.41	0.35
Summer storms..	1.50	1.75	2.0	1.71	5.00	4.28	0.35	0.30
Spring storms...	2.00	2.25	1.5	1.33	3.75	3.33	0.26	0.23

Construction Details

The bar screen has a clear spacing of 1 in. and is 1 ft. 8 ins. wide by 7 ft. 11 ins. long, inclination one on three.

The grit chamber has two compartments 46 ft. in length, of such cross-section, as to maintain a velocity of about 1 ft. per second for all flows. This desirable feature, of constant velocity is accomplished by the Venturi flume, which is placed at the outlet end of the grit chamber. The head required for discharge through the flume produces the desired back-water effect or depth in the grit chamber.

The venturi flume has a rectangular cross-section throughout, a throat width of 12 ins., and an over-all length of 14 ft. The flume is constructed in accordance with the "Improved" design suggested by Ralph L. Parshall, Irrigation Engineer of the U. S. Reclamation Service. The feature of special interest in connection with this design is the hydraulic jump produced beyond the throat. This prevents the complicated back-water effect of variable flow at the contracted section and permits accurate determination of the discharge with only one head reading.

The sewage meter, an indicating, integrating, and recording meter is installed in the office. The meter is actuated by a float, operating in a stilling well, which is connected with the venturi flume.

The primary clarification tank is 45 ft. square, has a depth below water surface, at side, of 8.5 ft., and is equipped with a Dorr traction mechanism for sludge removal. This tank provides a detention period of two hours and a surface rate of 763 gallons per day for a sewage flow of 1.5 m.g.d.

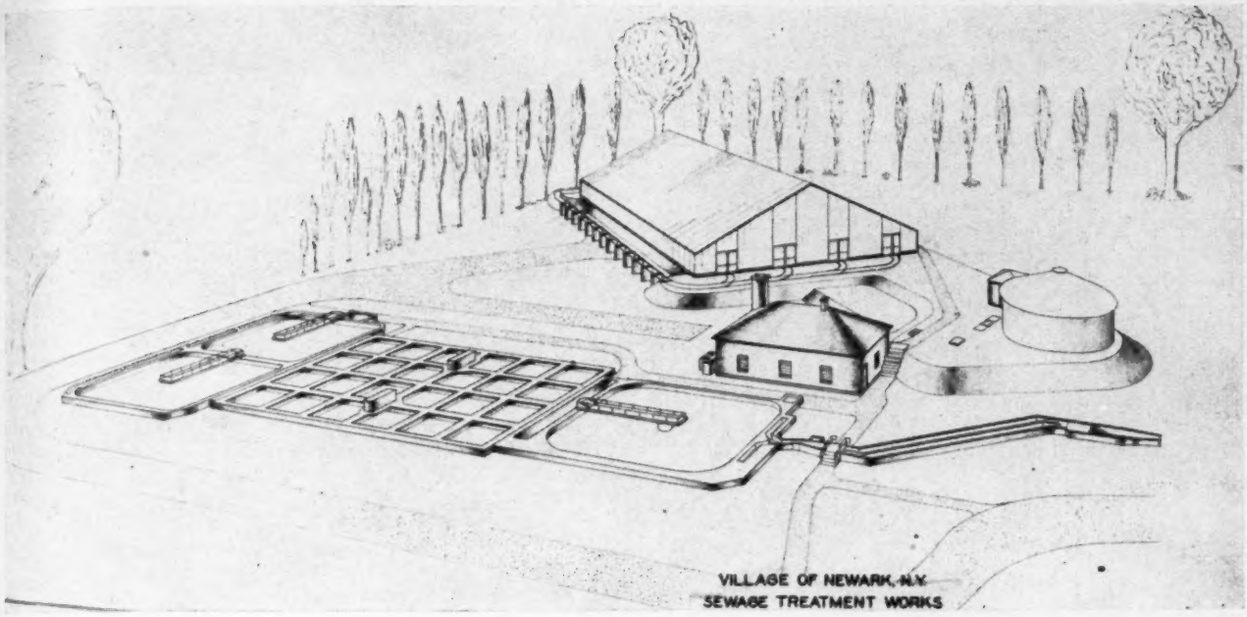
A by-pass channel, constructed integral with the clarification tank wall connects the venturi flume with the aeration tank and permits unwatering of the clarifier for inspection or repairs without interruption of the final treatment.

The aeration tanks, in duplicate, are 27 ft. wide, 75 ft. long and 14 ft. deep. The paddles are attached to two shafts extending lengthwise in each tank and are rotated by a 5 H. P. motor, through speed reducer, and chain drives. Diffused air is admitted through filtros plates placed midway between the paddles, 4 ft. above the tank bottom.

The two final clarification tanks are 35 ft. square, 9.0 ft. deep at the side, and are equipped with Dorr traction mechanisms. The inlet connections permit cutting either tank out of service and the other tank receiving the combined flow from the two aeration tanks.

The two sludge digestion tanks are equipped for gas collection and temperature control by circulation of hot water through coils. Alterations of the old Imhoff tank, 29 ft. circular, and 38 ft. in depth, included removal of the interior walls of the settling compartment, increasing the height of the outside

*The capacity of the aeration and final clarification tanks is computed for an addition of 25 per cent return of activated sludge.



Layout of Sewage Treatment Works in Village of Newark, N. Y.

walls, and the construction of a gas-tight cover.

The new digestion tank is circular, 30 ft. in diameter, 23 ft. deep, and is equipped with a Dorr mechanism for agitation, breaking up of scum, and removal of sludge. The alterations of the old final settling tank for sludge storage and conditioning, required increasing the height of the outside walls and the construction of a concrete cover. Neither gas collection nor heat control is provided.

These three tanks provide a total of 3.2 cu. ft. per capita, future population, for digestion after making allowance for supernatant liquor.

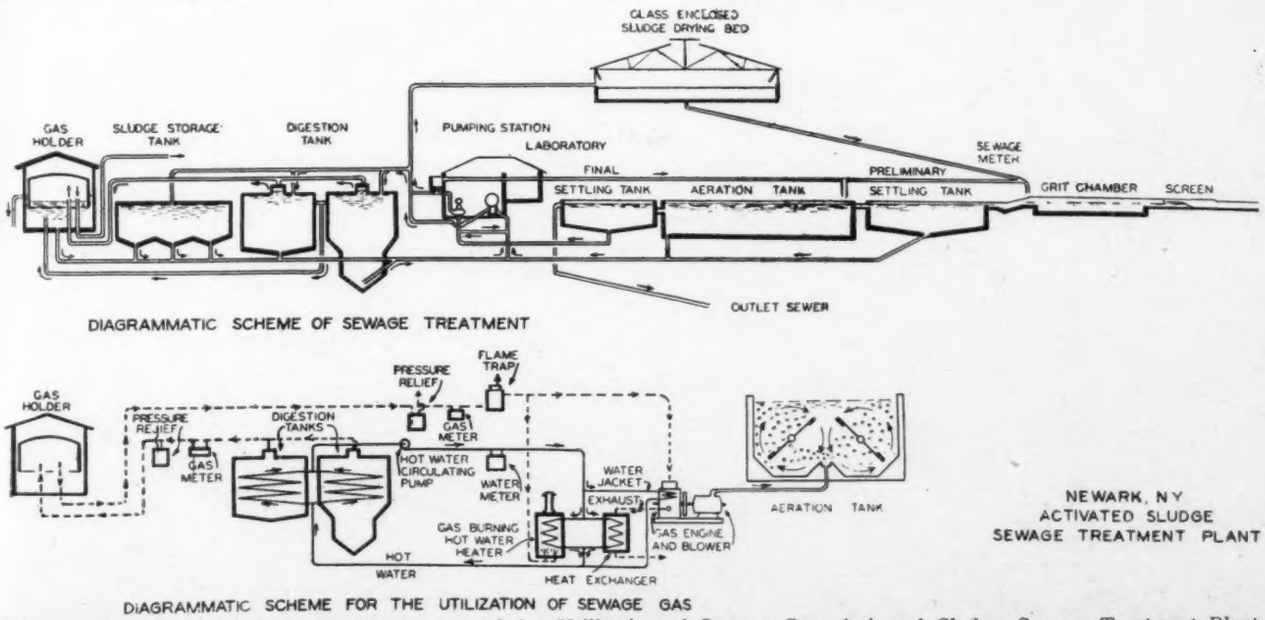
The gas holder has a capacity of 5,000 cu. ft. The diameter of the well is 26 ft., the diameter of the lift, 24 ft., and the water depth, outside of lift is 11.0 ft. Gas is stored under a pressure of 6 ins. water.

The design of the holder was predicated upon the assumption that one cubic foot of gas per capita per day would be obtained from digestion of the mixed raw and activated sludge, or from 7,000 cu. ft. per day shortly after starting operations, to 10,000 cu. ft. per day in 1950.

Sludge drying beds.—The existing sprinkling filter was reconstructed for sludge drying by removing the nozzles, risers, and the upper 2 ft. of stone, resurfacing with 12-ins. of graded gravel and sand, and erecting a glass enclosure on the existing walls. The surface is divided into 8 beds, 20 by 15 ft. by removable plank partitions. The total area provided for sludge drying is about 12,000 sq. ft. or 1.2 sq. ft. per capita.

The pumping station required considerable alteration and repair in order to place it in suitable condition for housing the pumps for raw and return activated sludge, the gas engine driven, and motor driven blowers, other miscellaneous equipment, the laboratory and office.

Mechanical Equipment.—The pump for handling



Diagrammatic Schemes of Sewage Treatment and for Utilization of Sewage Gas, Activated Sludge, Sewage Treatment Plant, Newark, N. Y.

raw sludge is of the variable stroke, displacement type, with a maximum capacity of 4,500 gallons per hour, against a head of 35 ft. It is operated by a 5 H. P. motor.

The two vertical centrifugal, return sludge pumps have a capacity (each) of 325 gallons per minute against a total head of 8 ft. and a capacity of 50 gallons per minute for a total head of 14 ft. The pumps are driven by direct connected, constant speed 2 H. P. motors. The variable rate of pumping is accomplished automatically by the variation of the sludge level in the return sludge well. The sludge level in the well depends upon the rate at which sludge is withdrawn from the final settling tanks and may be increased or decreased by raising or lowering the telescopic weirs on the sludge discharge pipes from either of the two final clarifiers.

Two rotary blowers furnish air under 5 pounds pressure for the activated sludge process. One is driven by a direct connected 15 H. P. motor and delivers 400 cu. ft. of air per minute. The other is driven by a direct connected, 15 H. P. Fairbanks Morse, Z-type, gas engine, and the delivery may be varied between 300 and 400 cu. ft. per minute, by regulation of the engine speed governor.

The hot water, circulated through coils in the digestion tanks by a small centrifugal pump and motor for temperature control is obtained from the water jacket of the gas engine and from the "Paracoil" heat exchanger, through which the hot exhaust gasses of the engine are passed.

Gas control includes the usual equipment of safety devices, pressure relief, flame traps, aluminum check valves, etc. Gas from each digestion tank is metered separately before passing to the gas holder. The gas used is also metered.

Construction

The work of construction and the furnishing and installation of equipment was awarded to Scott Brothers Construction Co., Inc. of Rochester, N. Y., Dec. 9, 1931. The final estimate given under date of Dec. 29, 1932, totaled $116,977.51.

The more important equipment was furnished by the following manufacturers:

Clarifier, digestion tank, and paddle wheel mechanisms, and the raw sludge pump—The Dorr Company, Inc.

Return sludge pump—The Rumsey Co.

Blowers—Roots Connersville.

Gas engine—Fairbanks-Morse Co.

Heat Exchanger—Davis Engineering Co.

Gas and coal burning hot water heaters—Bryant Heater Mfg. Co.

Air and sludge meters—Bailey Meter Co.

Gas meters—Pittsburgh Equitable Meter Co.

Air filters—American Filter Co., Inc.

Filtros, diffuser plates—General Filtration Co., Inc.

Glass enclosure—Lord & Burnham.

Gas holder lift—McClintock Marshall Co.

Valves—Chapman Valve Co.

Laboratory apparatus—The Will Co.

Plant Operation

The plant was started in operation about October, 1932. No more than the usual difficulties were experienced in preliminary operations at this season of the year. The digestion tanks passed through the customary foaming period without difficulty. Gas production reached a peak of 18,120 cu. ft., about 2.5 cu. ft. per capita on Dec. 24, 1932, and then dropped to the anticipated quantity.

The performance of the plant is indicated by the following tabulation abstracted from the operator's report for the week ending April 15, 1933. (Average for six days):

Sewage treated	901,000 gal.
Total suspended solids, raw sewage	296 p.p.m.
Total suspended solids, primary effluent	96 p.p.m.
Total suspended solids, final effluent	10 p.p.m.
Stability final effluent (Meth. Blue)	20 days plus
Gas from sludge digestion	7,487 c.f.
Air supplied aeration tank	0.60 c.f.g.

A paper, giving a more complete description of this plant, and its operation is being prepared for the convention of the New York State Sewage Works Association, to be held in Rochester, N. Y., June 9, 1933.

Visitors are always welcome at the plant which is being operated by Thomas J. Smith under direction of L. H. Wright, Village Superintendent.

The plans were prepared, the construction supervised, and the plant is being operated under direction of the writer, and Earl F. O'Brien, Associate, Consulting Engineers of Syracuse, N. Y.

James R. McClintock

James R. McClintock of the firm of Fuller & McClintock died on April 11 of a heart attack following an illness of several weeks with influenza and bronchitis.

Mr. McClintock was born in Malden, Mass., in 1883, the son of the late J. Y. and Mary Robinson McClintock. His father was at one time City Engineer and Commissioner of Public Works of Rochester and later County Engineer of Monroe County.

Mr. McClintock was educated at the University of Rochester and the Massachusetts Institute of Technology from which he was graduated in 1906. His entire professional career was spent with Hering & Fuller, the firm of George W. Fuller and since 1916 as a partner in the firm of Fuller & McClintock. The major portion of his professional career was devoted to design work for the firm in the fields of water supply, water purification, sewerage and sewage disposal. His recent and best known work was his immediate charge of the design of the Wards Island sewage treatment project of New York City. Prior to that he was in charge of the Toledo office of the firm directing design work for Toledo, Lima and several projects in Florida. During the period 1921 to 1925 he devoted most of his time to the Kansas City projects, having charge of the design of the new water supply and purification works of that city.

Mr. McClintock was a thorough-going student of engineering projects and had an unusually clear vision as to how work should be assembled in order to serve the objective sought. When he had visualized a program to his satisfaction it was with extraordinary energy that he made them of record by conducting the work in his characteristic way. His colleagues had a high appreciation of his technical skill as an engineer.

Interested in things artistic, while still a high school student at Rochester, he received a first prize for the design of a school building. He was a man of great simplicity of character and friendliness and all those who knew him admired him for these qualities.

Mr. McClintock was a member of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Consulting Engineers, American Water Works Association, and the American Public Health Association.

WATER SUPPLY FOR TANNERIES

By AUG. C. ORTHMANN

Director, The Orthmann Laboratories, Milwaukee, Wis.

Aug. C. Orthmann, the author of this article, has been connected with the tanning industry since 1908—having been Chief Chemist for one of the largest tanners in America. Since 1929 he has operated his own laboratories, serving the tanning industry.

This is the second article contributed by Mr. Orthmann; the first, appearing in WATER WORKS AND SEWERAGE for April, describes the different processes of tanning leather and depicts to what extent water supply plays a part in the operations.

In the present article, a highly important matter—the quality and quantity of water required in tanning practices—is dealt with.

TANNING is far from being an exact science; it is still considered one of the arts. The art of tanning has been handed down from father to son, most of whom are owners of plants, large or small, in the industry. The practical tanner, or superintendent in charge of a plant has learned the art by practical experience, and few have had a thorough training in chemistry; although the entire process of tanning is a complicated chemical procedure, the numerous applications of various materials as well as amounts used make the tanning of leather extremely complicated. Certain fundamentals, however, must be observed in order to obtain a proper "balance" of conditions for producing a leather of good grade for the market. One of the most important factors entering into this "balance" is water.

The practical tanner distinguishes water as "hard" or "soft." A difference of opinion still appears to exist as to the permissible degree of hardness or softness of water for the different stages of the tanning process. The chemist, however, is able to define the type of water to be used.

Specification of Water Quality

It is a rare case when any one tannery can function properly with one type of water supply throughout the year. If composition is suitable, temperature may not be satisfactory, especially in the summer months. For this reason it is important and desirable to have two sources of supply. The supply can be of great difference in composition and temperature and is defined as follows:

1. Total hardness not to exceed 8.0 grains per gallon (136.8 p.p.m.*).
   Total alkalinity not to exceed 7.5 grains per gallon (128.2 p.p.m.)
   Iron not to exceed 0.1 grains per gallon (1.7 p.p.m.).
   Causticity, nil.
   Temperature not important.
2. Total hardness may be as high as 30. grains per gallon (513. p. p. m.).
   Iron not to exceed 0.1 grain per gallon (1.7 p.p.m.).
   Other components in proportion to hardness.
   Temperature, constant throughout the year, not to exceed 60 degrees Fahrenheit.

If it is possible to obtain a type like (1) having a constantly low temperature throughout the year, then type 2 is not necessary, except possibly for purposes of economy. Type (1) should not be considered ideal for all purposes, although it is quite satisfactory. For stages in tanning where soft water is desirable, it can be adjusted by the addition of condenser water.

Waters of a composition ranging between (1) and (2) should be treated if it is to be used for all stages of leather manufacture. Treatment with lime and soda, followed by filtration or settling is most satisfactory. Causticity exceeding 0.5 grains per gallon, however, should be avoided. Softening by means of a zeolite is satisfactory for most operations except coloring, or a combination of lime-soda and zeolitic softening can be used.

The stages of the tanning process at which water of the types (1) and (2) can be used are as follows:

		Type
1.	Soaking hides and skins	2
2.	Washington hides and skins	2
3.	Dehairing stage	2
4.	Bateing stage	1
5.	Pickling stage	1
6.	Tanning stage (chrome)	1
7.	Coloring stage	1
8.	Fatliquoring stage	1
9.	Bark leaching stage	1
10.	Tanning (vegetable)	1

For Stages 1, 2, and 3, it is of great importance that water of a temperature of 60° F. or lower be available.

It is at these stages where the largest quantity of water is used. The ratio of water to hide should be 4 to 1; for a pack of 3,300 pounds; no less than 1,450 gallons of water is used. To properly wash such a pack will require approximately 5,000 gallons of water. The limes for dehairing should also be kept at a low temperature, the ratio of water to hide again is kept at 4 to 1. Washing at this stage requires from 4,000 to 4,500 gallons. The purpose of the low temperature is obvious, namely, to inhibit bacterial action, especially in the soaks, and to prevent hydrolysis in the limes.

For Stages 1, 2 and 3 a water of Type (2) is ideal and the tanner having such a source of supply is envied. The composition is of little importance in Stages 1 and 2, excepting that undue causticity should be avoided because it has a tendency to swell the stock excessively. The principal object is to cleanse the stock thoroughly of dirt and salt.

For Stage 3, a large excess of lime is always used with the addition of small amounts of sodium sulfide which take care of all softening effect necessary. All stock whether for chrome or vegetable tanning is treated similarly up to and including this stage.

Before entering the bate (Stage 4) the stock should be washed in water of Type (1). The amount of water in the bate is in the ratio of 5 water to 1 stock, and a total of about 5,000 gallons is consumed. At this stage it is important that the calcium salts in the stock be reduced to a minimum, for that reason a water of Type (1) should be used.

The pickling and chrome tanning stages require but

*p.p.m. = parts per million by weight.

small amounts of water. Pickle baths are used a number of times being adjusted as to strength of salt and acid for each lot. Tanning, when performed in the drum, requires about 1,000 gallons. For these and subsequent stages, water of Type (1), low in hardness, is necessary.

Importance of Thorough Washing

Stages 7 and 8 require about 10,000 gallons or more of water. Before coloring, all chrome tanned leather must be neutralized and washed to free it from soluble salts. Although the salts do not interfere with dyeing proper these are less difficult to get rid of them at that stage. The stock is always rinsed after coloring, but it should not be subjected to drastic washing, or difficulty is experienced in obtaining the proper color. If washing at this stage is insufficient to remove soluble salts, principally the sulfates and chlorides of sodium, these will later appear as minute crystals on the surface of the leather after it is finished. Once the leather is dried it is practically impossible to remove soluble salts by subsequent washing without in some manner effecting its appearance. Lack of proper washing can readily be detected by chemical analysis. Before such an analysis is completed the stock is well along in the process of drying for no interruption should take place in the progress at this stage. The result is that lack of washing is detected only after the leather is finished, and at a time when it is ready for the market or already on the market. In order to correct this condition leather would have to be re-worked and invariably such a lot ends up as a job lot.

Importance of pH Control

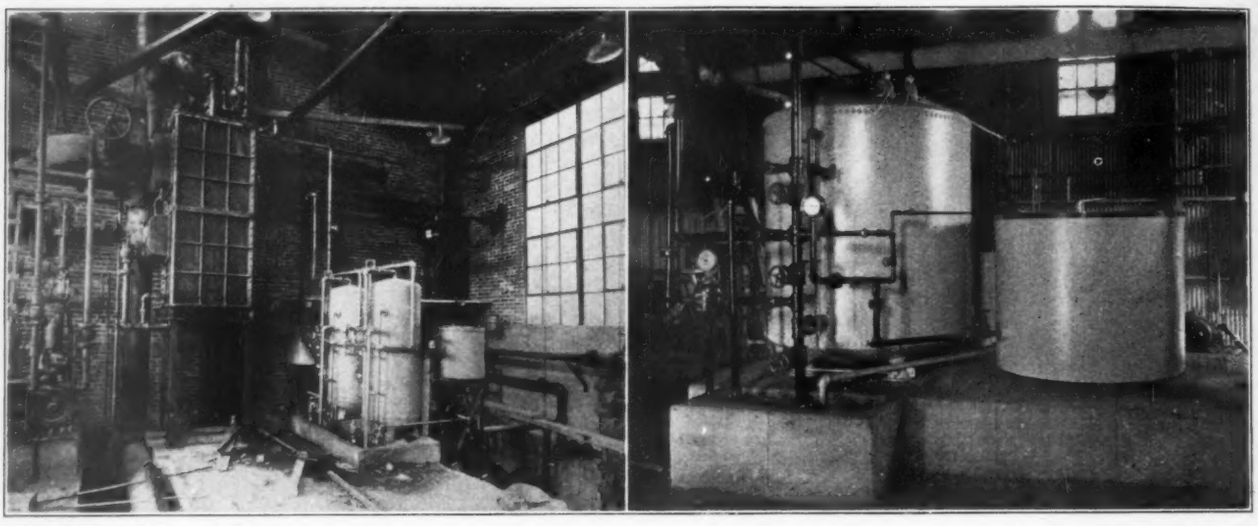
Coloring is principally done with aniline dyes. Acid direct, and basic dyes are used in conjunction with wood or natural dyes, and small amounts of vegetable tanning materials. Many shades required are delicate, and conditions in the coloring department must be under rigid control in order to produce uniformity for different lots of leather day after day. Most dyes are very sensitive to slight variations in acidity or alkalinity which in a large measure is controlled by varying the amount of neutralizing agent used, but subsequent washing affects this condition decidedly unless the type of water is duly considered. Water for this purpose should be soft, but not alkaline, and as free from calcium salts as possible. Water of high alkalinity used for washing stock before neutralizing will create a higher pH value than is permissible, no matter whether the shade be black or a pastel. The stock before coloring should show a pH value of from 5.0 to 5.5 as a rule.

The above operation is an example of proper "balance" which must be obtained by varying the amount of alkali used for neutralizing, or, by regulating the amount of water used for washing, but bearing in mind that washing must be complete.

In order to produce soft pliable leather it is necessary to stuff it with oils and greases, in the case of heavy leathers. Lighter leathers are "fatliquored" with emulsions of oils and soaps. It is extremely important that water containing a minimum of calcium salts be used for this operation, otherwise the "fatliquor" may be partially decomposed with the formation of calcium soap or the calcium soap may be formed on the surface of the leather and is very difficult to remove.

Preparation of Tan Liquors

Most large tanners of vegetable tanned leather prepare tan liquors by leaching barks, woods, nuts, and pods. For this purpose a water of Type (2) cannot be used, because it contains large amounts of calcium salts. The latter form insoluble compounds with tannin, resulting in a considerable loss. Water of Type (1) can be used but it is not ideal. Each cord (2,200 pounds) of bark requires approximately 1,000 gallons of water for thorough leaching. An average size tan vat will hold 2,000 gallons of tan solution. A tannery producing 1,000 sides of leather per day must be prepared to handle approximately 2,000,000 gallons of tan liquor in vats. Of this amount about two percent or 40,000 gallons is discarded daily due to complete exhaustion of the tannin content. Excepting for sole leather, the amount of water used for cleansing the stock is about the same as for chrome tanned leather. Sole leather is not washed as thoroughly because it is to have it retain as much of the absorbed and adsorbed matter as possible in order to obtain weight, firmness, and plumpness.



Left: Zeolite Softeners in Plant of Surpass Leather Co., Gloversville, N. Y. Right: Permutit Softener in Tannery of S. H. Frank Co., Redwood City, Calif.

Quantities of Water Required

The quantities of water consumed may vary in different plants. The size of the "pack" may also vary. The figures given above refer to a pack of 3,300 pounds.

Total water consumption for all purposes including making of steam for power requires 6,750 cu. ft. (50,625 gals.) per pack. This figure is an accurate measurement over a year's period of tanning 11,310 packs of leather. A total of 77,342,500 cu. ft. (580 million gallons) of water was consumed. Condenser water from the power plant was recovered and used and is included in the above figure.

The plants at which the above measurements were taken used Type (2) water for soaking, and beamhouse work up to the bateing stage. This water was obtained from a well 2,200 ft. deep, equipped with a pump supplying at maximum 450 gallons a minute, having a constant temperature of 52° F. throughout the year. About one-third of the total water used was from this source.

Type (1) water was used for all other operations excepting in the coloring department where condenser water was mixed with Type (1) water. This plant used city water obtained from Lake Michigan which cost the tanner 7 ct. a 100 cu. ft. A substantial saving was effected by the use of Type (2) water wherever possible.

Water which is obtained from streams varies decidedly in composition, and uniformity of leather production does not prevail unless the water is treated. Zeolite treated water is satisfactory for most operations, excepting that coloring, because of the sensitiveness of most dyes to an alkaline bath, and the difficulty of proper neutralization and complete washing at this stage.

When choosing a location for a tannery, water supply must be given due consideration. Locations near streams appear to be desirable, however, a careful survey must be made and seasonable variations taken into account. The presence of organic matter presents a hazard because it is conducive to rapid bacteriological action. The greatest danger occurs in soaking of hides and skins. If the source is from a large body of fresh water such as the great lakes, or from artificial lakes which are sources of supply for domestic consumption little or no difficulty is experienced. The cost of water from such a source as a rule is high and forms an important item in leather manufacturing. Most tanneries are provided with deep wells, many of which treat and filter part of their supply so it can be used generally.

The number of hides and skins tanned in the United States for the year 1931-1932 is shown by the following table:

Kind	1931	1932
Calf and kips, whole skins	11,775,000	11,578,000
Kip, for sides, whole skins	1,788,000	1,537,000
Cattle hides, for sole, harness, bag, etc	16,042,000	14,620,000
Goat and kid skins	47,596,000	36,172,000
Sheep and lamb	32,363,000	27,787,000
Cabretta	1,702,000	1,256,000

The figures do not include Kangaroo hides, deer skins, or skins of fur bearing animals.

▼

R. F. C. Loans for Water Works

Through the self-liquidating features of the Emergency Relief and Construction Act of 1932, a total of 59 cities and towns in 24 states and one territory had negotiated loans through the Reconstruction Finance Corporation up to April 27 for water works. The total cost of these projects will be $58,038,250, and the approximate direct employment will total 30,644,840 man-hours. In addition thousands will be employed indirectly in manufacturing the material required for these improvements.

A survey shows that Kentucky municipalities profited most by this form of federal relief legislation. Eight towns in Kentucky have arranged to build new systems or to modernize old ones and increase their capacity. In Ohio, seven towns have obtained loans for water supply systems and Texas is third in number with six loans for this purpose. Others include Illinois, 5; Utah, 4; and California, 3.

Self-liquidating loans to build water supply systems have been the most popular ones under the emergency relief act. In most cases, the municipalities have been able to fulfill all requirements of the law and offer adequate security for repayment of the loan within a reasonable time, with estimates indicating sufficient revenues to amortize the loan. The board has shown itself eager to make the loans where all legal requirements can be met.

The list of loans approved for water systems projects follows:

State	Project	Amount
Alabama	Town of Sulligent	$ 38,000
	Town of Thomasville	20,000
Arizona	Pima Water Company (Pima)	13,500
	City of Prescott	50,000
California	Metropolitan Water District of Southern California (Los Angeles)	40,000,000
	City of Pasadena (S. Gabriel Dam)	5,508,000
	City of San Diego	2,350,000
Florida	City of Pensacola	50,000
Georgia	Town of Ball Ground	19,000
	Tybee Water Works (Savannah Beach)	22,000
Illinois	City of Chicago	2,327,000
	City of Columbia	52,500
	City of Mt. Carmel	100,000
	City of Virginia	100,000
	Village of Wilmette	580,000
Indiana	Michigan City	300,000
	City of Union City	45,000
Iowa	Town of Montezuma	9,700
Kentucky	City of Columbia	29,000
	City of Flemingsburg	75,000
	Town of Greensburg	40,000
	Kenton County Water Commission, District No. 1 (Covington)	35,000
	City of Marion	35,000
	Town of Owenton	65,000
	City of Owingsville	49,000
	City of Raceland	40,000
Louisiana	City of West Monroe	55,000
Missouri	City of Illmo	42,000
Nebraska	City of Long Pine	15,000
New Jersey	Township of Denville	80,000
New Mexico	Village of Hatch	16,500
	Town of Springer	37,500
New York	Wanakah Water Company (Buffalo)	70,000
	Village of Saranac	8,000
North Carolina	Roanoke Rapids Sanitary District	365,000
	Town of Sanford	45,000
Ohio	Village of Bethel	35,000
	Village of Coal Grove	62,000
	City of Conneaut	200,000
	Village of Crestville	40,000
	Village of Roseville	15,500
	Water Department, City of Sandusky	77,000
	Village of Williamsburg	38,000
Oklahoma	City of Hobart	250,000
Oregon	City of Dufur	10,000
Porto Rico	Capital of Porto Rico (San Juan)	1,300,000
Texas	City of Commerce	13,250
	City of Corpus Christi	500,000
	The Fabens Water Company, Inc. (Fabens, El Paso County)	15,000
	Tarrant County Water Control & Improvement District (Fort Worth)	463,000
	City of Glen Rose	45,000
	City of Woodville	20,000
Utah	City of Ogden	645,000
	Riverton Pipe Line Company (Riverton)	20,000
	Town of Santa Clara	6,300
	Vernal City	38,000
Virginia	Town of Brookneal	27,500
Washington	City of Seattle	1,491,000
Wisconsin	Village of Hartland	40,000
	Total	$58,038,250

CHEMICAL TREATMENT OF SEWAGE AS ADJUNCT TO SPRINKLING FILTER OPERATION

By JOHN R. DOWNES

Supervising Engineer, Joint Sewage Treatment Works of Plainfield, N. Plainfield and Dunellen, Bound Brook, N. J.

John R. Downes

CHEMICAL precipitation, in the usual sense of the word, involves complex reactions productive of a voluminous flocculent precipitate which gathers to itself finely divided particles in suspension and drags them down, thus clarifying the liquid. A distinct change in hydrogen ion concentration is usually required in such precipitating reactions.

Employing small dosages of iron salts such as we have found to be effective in removing much of the organic matter from sewage received at the Plainfield Joint Treatment Plant, no such change in hydrogen ion concentration takes place. It seems probable, therefore, that the organic matter removal observed by us when applying such small dosages of iron salts constitutes a phenomena akin to that observed in dyeing and mordanting wherein the iron or other metallic salt is absorbed by the organic fibers of the textile. In the case of sewage, the coagulant appears to be absorbed by organic suspended matters and a weighting down effect is produced. Considered as a mordant, the action of the iron salt is seemingly selective in its reaction on the organic matter which we seek to remove, causing separation and precipitation *without the formation of a voluminous floc.* It has thus been possible to secure an appreciable reduction of organic matter without a proportional increase in sludge volume.

The Process as Developed

In the title of this paper the term "Chemical Treatment of Sewage" is intentionally employed to designate the application of the coagulant in modern quantities, and in a somewhat novel manner. In contradistinction to this, the term "chemical precipitation" is usually applied when sewage is coagulated to an extent that will produce a sparkling effluent, if efficiently settled or when filtered through mechanical filters. The latter produces materially increased sludge volumes and is relatively expensive. The treatment described herein is inexpensive, produces only moderately increased volumes of sludge, removes appreciable quantities of the organic non-settleables, and consequently lowers the loading on the sprinkling filters by approximately 50 per cent.

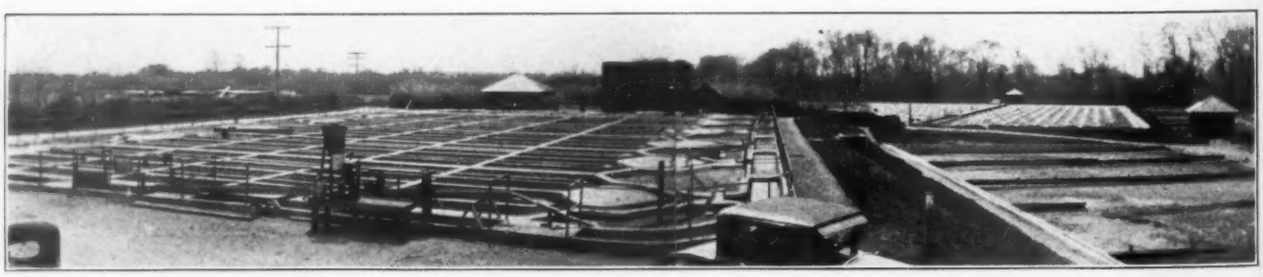
This scheme of treatment was developed to improve conditions with which we were faced at the Joint Disposal Plant. The sprinkling filters have been successfully carrying a population load 25 per cent greater than that for which they were designed. Odors from the sprays and filter flies have been troublesome. Both of these difficulties appear to be connected, in some measure, with the intensity of organic loading on the filters, especially with stale sewage. The sewage reaching the plant is rather highly concentrated, and becomes very stale during its travel through the long flat sewers.

Preliminary experiments with chemical precipitation, suggested by Fuller and McClintock, Consulting Engineers, proved discouraging because of the large quantity of chemicals which appeared to be required. With strong sewage no clean cut floc formation could be obtained with less than 1,200 pounds of ferric chloride per million gallons of sewage treated. It did not look promising to say the least.

In treatment of highly organic waters in Panama, the writer had found it possible to produce a clean "break" and good clarification, with a marked reduction of coagulant, by employing rapid agitation of the water during introduction of the chemical. Application of this principle to the treatment of the Plainfield sewage made it possible to secure partial clarification by partial dosings. Employing effective agitation followed by a slow motion, a 50 per cent clarification of the sewage could be obtained with 400 pounds of ferric coagulant per million gallons. Later, the chemical requirement was further reduced; but feeling that the work thus far had brought the process of chemical treatment within the range of economic reasonableness, we next turned our attention to the treatment of the sprinkling filter effluent. It was found that, by applying the same flocculating principle, 200 pounds of iron salt per m.g. would remove all suspended solids from the bed effluent during a settling period of ten minutes.

Re-use of Chemical Sludge

Working with the above scheme, we found that the return of chemical sludge from the final tank to the



The Plainfield Joint Sewage Treatment Works. View from Laboratory Window; Sludge Digestors on Left Not in Sight. The Small Dry-Feed Machine in Left Foreground Feeds Ferric Sulphate to Final Tank Sludge to Precipitate It in the Primary Settling Units, the Latter Being Converted Imhoff Tanks.

primary settling tank influent absorbed odors and increased the rapidity of settling. When the filter bed effluent was coagulated with 200 pounds of iron salt per m.g., and the precipitated sludge was pumped to the incoming screened sewage, interestingly enough, practically the full value of the chemical was again available. That is to say, if the required coagulant dose to the screened incoming sewage proved to be 400 pounds per m.g., the final tank sludge returned to it, plus an additional 200 pounds of unused chemical, accomplished the same result.

Application in Practice

On a practical working basis, the chemical dosage will be varied to meet changing flows and varying strength of the crude sewage. Since the object of treating the filter bed effluent is to produce complete clarification, this operation is one requiring a rather constant dosage of 200 pounds of the ferric precipitant per million gallons.

Experiments indicate that return of the sludge from

View of Sprinkling Filters, Plainfield, N. J., Sewage Treatment Works from Top of One of the Sludge Digestion Tanks.

the final tank to the incoming screened sewage will be all that is required from midnight to nearly noon. From noon on, additional chemical will be applied to the incoming screened sewage to the extent required to reduce, by 50 per cent, the organic load on the filters. Our earlier work indicated that the combined *maximum* rate of application would be 400 pounds per million. The average daily dose, for the combination of effluent clarification and oxygen demand reduction through the primary settling tanks, will be roughly 252 pounds of commercial sulphate of iron ("Calcoag") for each million gallons of sewage received at the plant. Recent experiences indicate, however, that a probable further reduction of chemical may be in order.

In the earlier stages of the investigation, we assumed that the degree of clarification of the sewage would bear a direct relationship to the reduction in organic load on the filters. However, after the preliminary work had indicated the economic practicability of our scheme, we went into the study of biological oxygen demand reductions and were surprised to find that a very remarkable reduction was had—notwithstanding the fact that the visible improvement was unimpressive.

Purification Obtained

Examining the tabulated results, one finds that the 200 pound dose, which is required to secure a properly clarified filter effluent, reduces the 48 hr. oxygen demand to a marked degree. The irreducible residual (not removable) appears to be but 3 parts per million.

The reductions in the oxygen demand of screened sewage, ranging from 50 per cent upwards, represent typical findings when applying 300 to 400 pounds of coagulant per million gallons—250 pounds or thereabouts being the average requirement for a 50 percent reduction.

TABULATION OF REDUCTIONS OF 48 HR. BIOLOGICAL OXYGEN DEMAND OF BED EFFLUENT WITH 200 POUNDS "CALCOAG"* PER M. G.

Sample	Date 3-10 Time 5:30p.	3-11 11a.	3-11 2:15p.	3-13 11:15a.	3-13 4p.	3-14 2p.	3-17 2:30p.
Bed Eff.	40	99	52	27	64	60	24
Bed. Eff. settled	20	24	24	6	..	27	15
Bed Eff. (200 lbs.)*	12	9	3	3	2.5	3	3

48 HR. BIOLOGICAL OXYGEN DEMAND AND TURBIDITY OF SCREENED SEWAGE TREATED WITH VARYING DOSES OF "CALCOAG"*

	Oxygen Demand						Turbidities PPM**	
	3-18	3-10	3-10	3-11	3-14	3-17	3-18	3-17
Screened Sewage	270	120	108	138	234	216	1640	1800
Screened settled 30 m.	246	...	...	...	132	136	840	725
Screened Sewage plus								
50 lbs.*	162	...	...	...	...	...	620	...
100 "	180	...	...	...	...	...	585	...
150 "	156	...	...	...	...	...	500	...
200 "	144	...	...	...	...	...	500	...
250 "	132	...	...	...	...	...	330	...
300 "	132	...	...	...	...	66	330	200
400 "	...	102	54	72	72	48	...	200
50 "	...	66	36	66	60	...	...	150

*"Calcoag" is commercial sulphate of iron containing 75%, or more, of available ferric sulphate $Fe_2(SO4)_3$.

**"Turbidity" measured by use of photo-electric cell.

Sludge Production and Digestion

The process in its present stage of evolution produces a volume of combined sludge (final-tank sludge and chemically produced sludge from the crude sewage) which is but 30 to 50 percent greater than the volume of sludge produced without chemical treatment. The process is, therefor, far less productive of sludge than would be the circumstances with true chemical precipitation as it is generally conceived.

The combined sludge digests readily and with a minimum of odor production. The chemically produced sludge mixtures digest without the usual acid stage of digestion, experienced when digesting ordinary sludges. Aside from this apparent advantage, it digests as does ordinary sludge.

Summary

A method has been evolved entailing the application of ferric iron coagulants to improve the operation and raise the efficiency of an overloaded sewage treatment plant.

The application of moderate, and therefore economical, quantities of coagulant, split between the effluent of the sprinkling filter and the crude sewage, to which the sludge from the final tanks is also returned, offers a novel and practical method of:

A —Producing a plant effluent attractive in appearance and of very low oxygen requirement.

B —Reduction of loadings on sprinkling filters or other biological units, thus increasing the capacity of the plant, and simultaneously eliminating odors.

C —Improving, rather than deleteriously affecting sludge digestion without adding appreciably to the sludge volume.

D —Securing a practical and economical scheme (for seasonal or continuous application) of improving plant efficiencies or increasing plant capacity during periods of overloading.

Acknowledgment.—The above article is a condensed statement of facts contained in a paper read by the author before the New Jersey Sewage Works Association, at Trenton, N. J., March 24, 1933.

NINTH ANNUAL MEETING OF THE MICHIGAN SEWAGE WORKS ASSOCIATION

THE Ninth Annual Meeting of the Michigan Sewage Works Association was held at Michigan State College, East Lansing, Mich., on March 30-31, 1933. Prior to the meeting of the association a two day short course in methods of analysis was given by the members of the college staff.

E. C. Miller, Superintendent of Sewage Treatment at Dearborn, Mich., opened the conference with a paper on the "Chemical-Mechanical Treatment of Sewage at Dearborn." Mr. Miller described the various processes employed at Dearborn and the degree of purification being obtained at this plant. Because of the peculiar conditions existing at Dearborn no operating cost data was presented. Following the presentation, a very lively discussion ensued which continued until adjournment for lunch.

A talk on "Prevention of Accidents at Sewage Treatment Plants" was given by R. E. Kelley of Sturgis. Lack of time prevented a complete discussion of the topic, but several very important points were developed by Mr. Kelley. It seemed to be the consensus of opinion that further papers along this line should be presented.

Dr. Carl Hubbs of the Institute of Fisheries, University of Michigan presented a highly interesting talk on the "Relationship of Sewage Pollution to Fish Life."

The experiences in sewage chlorination during the past three years at Flint, Mich., were briefly summed up in a paper by P. R. Welch, Superintendent of the Flint Treatment Works. He spoke of their "Experiences with Chlorination" for several purposes, including odor control, both at the plant and in the long conduit delivering the sewage to the plant; on relief of pooling on trickling filters; on attempted chlorination for relief of loading on a stream prior to completion of the treatment works, and for the control of plankton and algae in the stream following the installation of the filters.

N. G. Damoose, chemist at the Grand Rapids Sewage Treatment Plant, presented an interesting talk on "pH Determinations." Mr. Damoose has conducted a series of experiments with five different kinds of apparatus for measuring pH values. Determinations were made using all the different types of apparatus on samples of distilled water, tap water, raw sludge, diluted raw sludge, clear liquor from sludge and several others and he showed by means of graphs the results obtained from each piece of apparatus.

Descriptions of "The Activated Sludge Plants at Muskegon Heights, Escanaba, and Woodstock," were given by L. D. Suhr of Chicago, the designing engineer for these plants. All three of these plants use mechanical aeration, and the first two a combination of paddle wheels and air blowing. A gas engine using digestor gas for fuel furnishes part of the power at Escanaba.

Frank C. Roe, Sanitary Engineer, Carborundum Company (Left Rear); F. R. Theroux, Michigan State College (Left Front); C. T. Mudgett, Chairman, Pontiac, Mich., President of the Association for 1933-34 *(Right Rear); Mr. Stone, Assistant Manager, Stream Control Commission of Michigan (Right Front).*

M. P. Adams, Secretary of the Michigan Stream Control Commission, gave a short talk on "Financing the Construction and Operation of Sewage Treatment Works." A recent opinion of the Attorney General relative to charges for sewer service by municipalities was presented. The possibility of using this type of work for relief of unemployment was also discussed.

A highly interesting talk on "Utilization of By-products of Sewage Disposal" was given by James R. Rumsey, Superintendent of Sewerage at Grand Rapids. This paper was wholly free from technical discussion but was devoted to a consideration of other phases of plant operation such as plant beautification, securing the support and good will of the community, the use of available ground for garden purposes, utilization of gas and producing and marketing fertilizer.

A "Question Box" conducted by C. T. Mudgett of Pontiac proved very interesting and excited a good deal of discussion. This feature of a program appears to be very popular.

At the annual business meeting the following officers were elected for the year 1933:

President—C. T. Mudgett, Pontiac.
Vice-President—P. R. Welch, Flint.
Sec.-Treas.—W. F. Shephard, Lansing.
Director—M. P. Adams, Lansing.
Continuing Director from 1932—E. F. Eldridge,

Left to Right: W. F. Shephard, Assistant Engineer, Sanitary Engineering Division, Michigan State Board of Health, Secretary and Treasurer of the Association; James R. Rumsey, Superintendent Sewerage, Grand Rapids, Mich.; L. D. Suhr, Suhr, Berryman, Peterson & Suhr, Consulting Engineer, Chicago, Ill.; John Jellema, President 1932-33, *Michigan Sewage Works Association; P. R. Welch, Chemist, Flint, Mich., Vice-President of the Association* 1933-34.

N. E. W. W. A. HOLDS SPRING MEETING AT NEW BRITAIN, CONN.

ON April 26th the New England Water Works Association met in New Britain, Conn., the registration being but slightly less than 200.

The meeting, called to order by President R. N. Ellis, opened with

Round Table Discussions

"The Disinfection of Water Mains"

WARREN GETNER, Engineer of the Metropolitan Water Commission, Hartford, Conn., described the methods employed in Hartford, for disinfection of mains. He said that Mathieson's dry hypochlorite ("H.T.H.") had been a very satisfactory and practical material to use. The practice had been to place one-half pound of the powder in each 6th length of pipe, the same quantity being used as standard practice regardless of pipe diameter. When the line was filled slowly with water that amount would produce a dosage of chlorine varying between 18 parts per million for a 6 inch pipe to 3 parts for a 16 inch pipe. The line was allowed to stand about 30 minutes after filling and then thoroughly flushed until the test for chlorine was negative.

A second method, used mostly to disinfect mains that had been laid for some time prior to putting in service, entailed the use of a Chlorinator, or Main Sterlizer, and liquid chlorine. The water to operate the chlorinator was taken from the high pressure side of a valve on the main and chlorinator discharge was tapped into the main on the low pressure side while filling the line slowly. The chlorine water had to be injected against not more than 15 pounds pressure. The water is wasted at the end of the section being disinfected until a good strong test for free chlorine is had. After 30 minutes, the line is flushed thoroughly—the flushing being very important and preferably from two directions.

EDWIN E. MINOR, Manager of the New Haven Water Company, in discussing main sterilization, said that they at New Haven had found it an important practice. "H.T.H." had also been very effective at New Haven but a solution of it was applied to the interior of the pipe as laid, with a hand spray gun. The man using the spray would first clean the interior of the pipe if necessary before applying the disinfectant.

MR. WELLINGTON, Chemist of the New Haven Water Company, described the process employed, wherein liquid chlorine is applied, using a Wallace and Tiernan injector panel. This portable outfit, he said, had been easy to handle and required but 15 minutes to set up and start operating. The chlorine cost had averaged about $7.68 for 5,000 feet of 32 inch main. The plan followed had been very similar to that used at Hartford—applying just beyond a partially opened valve—but they had found it advisable to let the main stand filled with the superchlorinated water for 24 hours or longer. The dosage required to produce water containing 15 p.p.m. of free chlorine, at the far end of the section being chlorinated, was always aimed at but they had found as little as 1 p.p.m. effective after 24 hours' standing. No amount of flushing, alone, had cleared up the pollution in unsterilized mains. The chlorination process had been effectively applied to 4.5 miles of 48 inch pipe and shorter lengths of smaller mains. Mr. Wellington told of one case where a section of new line accidentally got filled with sewage but the disinfection process had proven timely and effective in that emergency.

E. S. CHASE, of Metcalf and Eddy, Engineers, Boston, Mass., made the request that detailed information covering the methods of main sterilization be supplied him as Chairman of the Association's Committee on Main Sterilization.

"Shutting Off Water for Nonn-Payment of Water Bills"

F. A. ALMQUIST, Assistant Engineer of the Connecticut State Department of Health, in opening the discussion of this important and timely topic, directed attention to certain regulations of the Department of Health, wherein shutting off water supply to rented properties, housing three or more families, was prohibited. He suggested that Water Companies or Water Departments notify tenants of rented property at least 30 days in advance of cutting off the supply.

S. H. MACKENZIE, Superintendent of Water Works, Southington, Conn., in an excellent presentation depicted the existing situation confronting the Southington Water Department, and many others, in respect to collecting water rents during the past 3 years. He said that regardless of the seriousness and magnitude of uncollected water bills, his Water Commissioners had deemed it advisable to investigate each case individually before shutting off water, even though the usual 60 day notice of intent to do so had been issued. After such investigations there had been some shut-offs but the water was in every case turned on again if nothing more than a partial payment on the bill was made. The Southington Water Department, he said, was accepting installment payments but naturally it was admittedly not practical because the cost of collection was far too great.

Mr. MacKenzie said, that by far the hardest bills to collect were those carrying an extra charge to cover the extension of water mains into sparsely built up territory. He, on that score doubted the soundness of the practice of making special rates to cover main extensions. He said that he thought that a house to house collection scheme and more frequent billings would prove of practical value in rendering it easier to collect water rents.

Top: President Robert H. Ellis, Commissioner of Water, Newton, Mass. Lower Left: Secretary Frank Gifford, Dedham, Mass. Lower Right: Chairman of Committee on Program and Arrangement, T. L. Bristol, President, Ansonia Water Co.

The right of lien upon property for unpaid water bills was the last resort. Re lief organizations, he said, had not thus far contributed anything in the way of paying for water supplied poor families. Considering water to be of paramount importance, he could not understand why such had not been done and wondered if it had been done elsewhere.

In reply to a question, Mr. MacKenzie said that money had been in certain instances collected from tenants who had deducted the amount from the rent before paying.

Mr. Hartford, representing a Water District of Norwalk, Conn., said that they were accepting installment payments on overdue water rents and that no lien was placed on the property for one year following absolute non-payment of bills. He referred to a bill now before the Connecticut Legislature which, if passed, will give the lien on property for failure to pay water rents priority in bankruptcy or foreclosure processes.

J. J. Watson, Chairman of the Water Commission of New Britain, spoke of the seriousness of the situation in New Britain wherein many residents had until now never in 30 years been in arrears on water bills. The experience of the past 3 years had indicated the advisability of building up a cash surplus in normal times to meet such situations as now exist in many cities. Water consumption by their best customers, the manufacturing plants, had dropped off by 27 per cent. In many instances the Water Department had accepted work in payment for water rents in lieu of cash. Mr. Watson remarked, that they had never used legal methods in collecting water rents until recently, when, certain consumers in arrears, had upon advice of "smart" counsel, notified the Department that no payment would be made. It was necessary to show them their mistake in having listened to faulty legal advice.

L. S. Carlton, Assistant Superintendent, Springfield, Mass. Water Department, reported that they had not gotten very far behind in collections. Every month shut offs total between 100 and 150—there being the $2.00 charge made for turning on the water again. In Springfield the Welfare Department has helped by paying up the back bills of worthy cases.

H. T. Gidley, Superintendent Water Department, Fairfield, Conn., suggested a method of providing a house with water sufficient to avoid health menace but making the service sufficiently inconvenient to create incentive to pay up. The scheme was that of inserting a 1/16th inch orifice disc in a union on the service line. Water would thereby be available but only at rates and pressures productive of much inconvenience to the user.

T. L. Bristol, President, Ansonia Water Company, Ansonia, Conn., told of the use of the unemployed and those behind in water rents in cleaning up and trimming wood-lands on the company's property and producing fire wood from dead and undesirable trees. More than 1,000 men had applied for such work and the wood had been of value along with the improvement.

It developed that New Britain and other cities had also followed a similar scheme to good effect.

"The Use of Unemployed and Relief Undertakings on Water Works"

The discussion of this topic was opened by Harrison P. Eddy, of Boston. Mr. Eddy, having served on important committees dealing with water works betterments legislation and plans, was well equipped to speak on this subject. He said that it had not proved profitable on the whole for Water Departments to accept work for unpaid bills. He said the great obstacle to utilizing water works betterments in unemployment relief programs was the need for $2.00 to buy tools and materials for every $1.00 expended for labor. Where and how to secure the 66 per cent to add to the 33 per cent for unemployment relief had been the stumbling block. Now, however, a movement was under way in Washington which will provide the funds for tools and materials in addition to labor.

The three major reasons for advocating relief through public works construction, Mr. Eddy listed as:

(a) Payment for labor rather than a hand-out as a dole. Such a plan maintained the self respect of the man.

(b) Creation of immediate and widely distributed buying power.

(c) Securing of valuable works at a very low cost.

He thought the last would probably carry the greatest appeal to thrifty people and taxpayers interested in securing "a bargain" along with relief work.

Mr. Eddy referred to the developments now under way in Washington wherein it was highly probable that the Federal Government would appropriate a fund of $1,000,000,000 for public works construction and betterments. A City, County, State or District would receive from the fund one dollar for every dollar put up to match the government's money, the combined sum to be used in the public works program. Such a plan would appeal strongly to cities needing improvements now, and likewise to those looking ahead, but it would be necessary to have all plans well laid to be ready to take advantage of the opportunity. Mr. Eddy closed his remarks with a recommendation that interested cities make ready to profit from this proposed program which had every indication of going through.

W. A. MacKenzie, City Engineer and Superintendent of Water Works, Wallingford, Conn., said that they had installed water mains in 1932 at the low cost of 40 to 60 cents per lineal foot for trenching and laying and filling and are preparing to lay additional mains. They proposed to use men who can work out their water bills. Some of these men had been employed on water-shed reforestation and they had been successful in clearing up practically all unpaid bills in 1932.

"Fire Protection Classification"

George W. Booth, Chief Engineer, National Board of Fire Underwriters, New York City, recalled that a committee from the New England Water Works Association had coöperated with his organization in drawing up the first schedule for grading cities and towns as fire risks in 1916. He said, that grading was covered under 7 main headings, and that water supply counted for 34 points out of 100—the next most important item being the character of structures (buildings). In water supply the most important single item was the question of proximity of stored water to the area served and the spacing of gate valves was another important item.

A matter of importance before the Underwriters at the present time, Mr. Booth said, was the question of what value should be given standby steam equipment, now idle as the result of electrification of the pumping station. He remarked that a change-over to electric equipment frequently weakened the "dependability" factor because often but one single transmission line served the station and, too, the reserve pump capacity was generally too low. Then, with a failure in electric operation, how quickly could the steam plant be gotten into operation? This and other questions had to be answered before a value could be assigned steam standby and reserve pumping facilities.

CAST IRON PIPE AND FITTINGS FOR SEWER CONNECTIONS

By H. ROLAND DEVILBISS

Department Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

THE house connection to the sewer is fully as important as the house connection to water mains, and the types of pipe and fittings used in its construction should be given careful thought. It is rare, nevertheless, to read or even hear of one engaged in both water and sewer work favoring any particular type of pipe and fittings or methods of constructing the sewer house connection.

Upon organization, the Washington Suburban Sanitary District took over control of approximately 55 miles of existing sewers within the boundary of the district, and connected to these lines were approximately 1,630 sewer house connections. In the construction of new sewer lines and in the maintenance of the existing sewer lines and sewer house connections during the past 14 years, we have been able to make certain observations covering the types of pipe and fittings and the methods best employed in construction.

Methods of Constructing House Connections

Since taking over operation and maintenance of the existing sewer lines in 1918, this district has constructed new sewer lines totaling approximately 160 miles and has constructed a total of approximately 8,700 sewer house connections. The material entering into, and the methods of constructing house connections, during this period have passed through three stages, as follows:

First—The connection to the main sewer was made by inserting either a 5-inch or 6-inch terra cotta Y-branch, if no branch had been placed at the time of installing the sewer. The connection from this point to the property line was 5-inch or 6-inch terra cotta pipe, in 3-foot lengths with deep and wide socket. The joints were made of cement.

To insert the Y-branch necessitated extra excavation along the line of the main sewer on both sides of the point at which it was to be made in order to remove a section of pipe. After placing the Y-branch and cutting a piece of pipe to replace the section removed three new joints had to be made on the main sewer. Most of the main sewers in which Y-branches had to be inserted carried a heavy flow of sewage, which required constant pumping during the work. It was impossible to calk the new joints tight enough with jute to keep some sewage from seeping back into the trench and this seepage prevented the making of good joints. Upon completion of the job we were unable to determine, due to the heavy flow of sewage, whether or not lips existed at these new joints. Lips occur even where the utmost care is taken and are constant sources of trouble, particularly in sewers where root removal is necessary from time to time.

Second—Connections to main sewers carrying a small flow of sewage were made in the manner just described, while on those carrying a heavy flow of sewage the connection with the main sewer was made with an extra heavy cast iron soil pipe fitting commercially known as the Washington Standard Thimble-Y. The Thimble-Y is made in 5-inch and 6-inch sizes and is inserted through an opening cut in the barrel of the main sewer slightly larger than the outside diameter of the fitting to be inserted. The Thimble-Y had a thin spigot 1 inch in depth which was inserted in the above-mentioned opening and was prevented from protruding into the barrel of the sewer by a flange which fitted neatly against the barrel of the pipe. A concrete collar was then placed around the Y and extended one foot on each side of the tap made in the main sewer. One of the disadvantages of the Thimble-Y was that it could not be used satisfactorily on sewers smaller than 8 inches, but it did have advantages over our previous method in that it eliminated extra excavation, pumping, and the possibility of lips in the joints of the main.

Third—Connections to the main sewer were made by means of 4-inch and 6-inch lightweight cast iron cut-in connections with bell and spigot ends, and the house connections from the main sewer to the property line were laid with 4-inch and 6-inch Class 50, centrifugally-cast C. I. pipe, in 12-foot and 18-foot lengths.

Cut-In Connections Developed

The cut-in connections, which were developed by Robert B. Morse, Chief Engineer of the Washington Suburban Sanitary District, and the writer, can be used for making either 90-degree or 45-degree connections with the main sewer, and have been used exclusively in our district since 1929. They can be used on terra cotta or concrete pipe sewers of all sizes, and in connection with house services of either terra cotta or cast iron pipe of the diameters usually required. On our sewer house connections we are using the 90-degree cut-in connection, where connections are required after the main sewer has been constructed, and terra cotta T-branches where a definite location for a connection can be made at the time the main sewer is being constructed. The 45-degree cut-in connection and Y-branches are used only in special cases where a connection can be installed more economically by extending it to the property line at this angle.

A saving is made by the use of the 90-degree connection over the 45-degree connection in that it eliminates the necessity for a 45-degree bend, which is required on at least 95 per cent of sewer house services extended from these latter fittings.

To insert a cut-in connection a hole equal to the outside diameter of the spigot end is cut into the barrel of the main sewer at the required angle for the extension of the sewer house connection. The spigot end of the cut-in connection is placed in the opening, and a small amount of jute is packed in the space between the spigot of the fitting and the rim of the hole in the main sewer. The cut-in connection is held rigidly in place by surrounding the outside of the fitting as far as the base of the bell, and along the main sewer itself for a short distance on each side of the fitting, with a lean cement mortar. The spigot end of the cut-in connection is provided with a bead which prevents jute or mortar from entering the main sewer, and two wings on the barrel allow the spigot end to enter the main sewer only sufficiently to be flush with the inner surface of the main sewer. The bead on the spigot and the wings on the barrel of the cut-in connection insure an unobstructed flow of sewage in the main sewer.

The bells of the cut-in connection have a centering

ring which insures the proper centering of either cast iron water pipe, soil pipe, terra cotta, or cement pipe and provides sufficient annular space to allow any type of joint to be made. The insertion of a cut-in connection in an 8-inch or 10-inch main sewer and the placing of the surrounding concrete does not usually require more than a half hour. On larger pipe, a longer time naturally is required for cutting the opening and the placing of a larger amount of concrete.

The process of cutting the opening in the main sewer, inserting the cut-in connection, and placing the necessary mortar is extremely simple, rapid and economical. The work can be accomplished with much better results than it is possible to secure when cutting in terra cotta Y-branches. The cut-in connection has a number of advantages over the Washington Thimble-Y. For instance, it is lighter in weight; requires a smaller opening in the barrel of the main sewer for insertion, thereby adding some additional strength to the structure; it has a spigot end which fits neatly the inside of the barrel of sewers of the different sizes; it can be used on smaller diameters of main sewer; and the bell is shaped for centering the house connection pipe.

Ready Set Y's and T's Discontinued in Favor of the Cut-In

When a sewer is constructed in a street, unless the property owner is ready to proceed with the connection to his house, it is exceedingly difficult to determine upon the location of the Y-branch or T-branch that will be satisfactory to him at some future date. As a result a great many of these branches have to be abandoned and in our district we have found it to be poor practice as well as uneconomical to place them on sewers ranging in size from 6 inches to 12 inches unless the property owner is ready to install his connection immediately. On sewers 15 inches and larger Y-branches and T-branches are omitted altogether. When applications are received for connection to the sewer constructed as outlined above, the cast iron cut-in connection is used exclusively.

Introducing Cast-Iron Pipe for House Connections

The use of 4-inch and 6-inch Class 50, centrifugally-cast C. I. pipe, in 12-foot and 18-foot lengths for constructing sewer house connections, from the cast iron cut-in connection, was begun around July 1, 1930. Our first order for Class 50 centrifugally-cast iron pipe specified only a small quantity of 4-inch which was to be used as an experiment in constructing sewer house connections. It promptly proved its adaptability to this class of work and the use of it has gradually increased until in 1932 approximately 60 per cent of our connections were constructed with 4-inch cast iron pipe. The remaining 40 per cent were constructed with 3-foot lengths of 6-inch terra cotta pipe, with deep and wide sockets, extended from the cast iron cut-in fitting tapped into the main sewer. This type of construction, however, is now being used only where underground structures and bad trenches require shoring and bracing, which renders the use of cast-iron pipe in 12-foot and 18-foot lengths inadvisable.

We are, however, considering the purchase of the 4-inch pipe with two spigot ends, cutting it to lengths that can be used under the above condition, and joining the ends by means of a cast iron double hub connection which will be described later on in the paper.

Before adopting centrifugally-cast pipe as a standard for use in constructing sewer house connections, a careful study was made of 4-inch, 5-inch and 6-inch pipe commonly used in this work and the outstanding features of this study are shown in Table I.

TABLE I

Kind of Pipe	Length Feet	4 In. Internal Diameter in Inches Nom.	Max.	Min.
Terra cotta	2½–3	4	4⅛	3⅞
Cement-concrete	2½–3	4	4⅛	3⅞
Cast iron soil pipe	5	4	4¼	3⅞
DeLavaud centrifugally-cast iron, Class 50	12–20	4 3/16	4 9/32	4⅛
Sand-spun centrifugal cast iron, Class 50	12–16.5	4 3/16	...	...
Sand-cast cast iron, Class A	12	3 31/32	4⅛	...

Kind of Pipe	Length Feet	5 In. Internal Diameter in Inches Nom.	Max.	Min.
Terra cotta	2½–3	5	5⅛	4⅞
Cement-concrete	2½–3	5	5¼	4⅞
Cast iron soil pipe	5	..	...	...
DeLavaud centrifugally-cast iron, Class 50	12–20	..	...	...
Sand-spun centrifugal cast iron, Class 50	12–16.5	..	...	...
Sand-cast cast iron, Class A	12	..	...	...

Kind of Pipe	Length Feet	6 In. Internal Diameter in Inches Nom.	Max.	Min.
Terra cotta	2½–3	6	6 3/16	5 13/16
Cement-concrete	2½–3	6	6 3/16	5 13/16
Cast iron soil pipe	5	6	6¼	5⅞
DeLavaud centrifugally-cast iron, Class 50	12–20	6¼	6 11/32	6 3/16
Sand-spun centrifugal cast iron, Class 50	12–16.5	6¼	...	...
Sand-cast cast iron, Class A	12	6 1/32	6 3/16	...

Referring to the data, it may be noted that the centrifugally-cast pipe can be secured in lengths ranging from 12 feet to 18 feet, the sand-cast iron pipe in 12-foot lengths, the cast iron soil-pipe in 5-foot lengths, the cement-concrete pipe and terra cotta pipe in 2½-foot and 3-foot lengths. The use of longer lengths results in more rapid installation, a reduction in the number of joints, and enables one to secure a much better grade and alignment than is possible with the other types of pipe shown. The reduction in the number of joints, in addition to the saving in labor and material, reduces to a minimum the chance of infiltration, root penetration, and lipped joints—all being sources of constant trouble to the maintenance engineer. Again referring to Table I, it will be found that centrifugally-cast pipe has a larger nominal, maximum and minimum diameter than the other makes of pipe shown. This feature, combined with the fact that the value of "C" in centrifugally cast iron pipe is generally agreed among engineers to be higher than in sand cast pipe and cast iron soil pipe, and is higher than in cement-concrete and terra cotta pipe, indicates a decided advantage in the use of centrifugal pipe. Therefore, the centrifugally-cast iron sewer house connection provides a considerably larger carrying capacity than can be expected from any of the other kinds of pipe shown.

In order that cut centrifugally-cast iron pipe may be reduced to a minimum we have designed and use a double hub (light weight) cast-iron fitting with a centering ring. This fitting is for joining the spigot ends of cut pipe and is used where the length of cut pipe is sufficient to warrant its use.

Our sewer house connections are divided into two classes, single and double, both ordinarily of 4-inch diameter where cast iron pipe is used. The single connection is constructed direct to the property line, while the double connection is laid as a single connection to a point between the curb and property line where it is

divided by means of a Y-branch, one branch being extended directly to the property line and the other branch extended at an angle of 45 degrees to serve the adjacent property. For the purpose of making this division we have designed and use a light weight cast iron Y-branch with centering rings in the bells. This Y-branch is much shorter in length than either the standard or extra heavy soil pipe fitting.

Jointing Materials Used Keep Out Roots

Joints on the centrifugally span cast-iron pipe sewer house connections have been made with leadite, mineralead, and an unnamed sulphur compound which was made up especially for us to be used on this work. All three of these joint compounds produce a practically water-tight joint, and we believe that any one of them when properly placed in a joint will resist the penetration of roots into the sewer house connection. However, the cost of the unnamed sulphur compound is slightly lower than that of the other materials. Joints on the terra cotta sewer house connections are poured with an asphalt joint compound.

Undoubtedly our largest cost of maintenance on sewer house connections is caused by clogging with roots. This root growth is present not only in old services where the terra cotta pipe joints may have been indifferently made, but also in numerous cases where the terra cotta pipe has been laid under our own supervision, the pipe being deep and wide socket and the joints carefully made with asphalt joint compounds. I recall one case where the connection became completely clogged within a period of 30 months. The pipe was 6-inch terra cotta, deep and wide socket, and the joints were made with an asphalt joint compound. An examination of the growth of roots in several joints showed that they had penetrated directly through the compound. Centrifugally-cast iron services with sulphur compound joints have been in service for a period of approximately three years and not one cent has been expended in the maintenance of them, a fact that is indeed gratifying. Practically all of the plumbers operating in our district construct the sewer house connection from the property line to the house with cast iron soil pipe and lead joints. This construction, coupled with our construction from the main sewer to the property line, comprises a high class piece of work—one that will remain tight and produce unlimited service at a low maintenance cost.

Cost of Installing House Connections

The number of sewer house connections completed and the average cost, including engineering and administrative expense, from 1927 to 1932, inclusive, are given in Table II.

TABLE II

Year	Total No. Connections	Terra Cotta Connections	Cast Iron Connections	Per Cent Cast Iron Connections	Average Cost
1927	929	929	0	..	$41.40
1928	648	648	0	..	43.33
1929	623	623	0	..	48.07
1930	607	551	56	9	45.41
1931	650	331	319	48	45.50
1932	571	229	342	60	42.14
1933	80	20	60	75	....
(To April 1.)					

From 1927 to 1929, inclusive, Y-branches and the Washington Thimble-Y were used for tapping the main, and the sewer house connections were constructed of terra cotta pipe, in 3-foot lengths, with joints made with an asphalt joint compound. The average cost of the connections through this period was $44.10 each. From 1930 to 1932, inclusive, Y-branches and the light weight cast iron fittings were used for tapping the main. The sewer house connections were laid with 6-inch terra cotta pipe and asphalt joint compound where necessary, but usually with 4-inch centrifugally cast iron pipe and sulphur joint compound. The average cost of the connections during this period was $44.35, an increase of $0.25 per connection. From the table it will be noted that in 1930, 9 per cent; in 1931, 48 per cent; in 1932, 60 per cent; and in 1933 to April 1, 75 per cent, of our connections were of centrifugally-cast pipe. Still the average cost in 1932 was $3.27 less than in 1930 and $5.93 less than in 1929 when labor and materials were at or near the peak. The table further reveals that the cost per connection in 1932 was lower than in 1928, 1929, 1930 and 1931, while it exceeded the cost in 1927 by $0.74 per connection.

Approximate average cost of labor and pipe for our sewer house connections from 1927 to 1932, inclusive, are shown in the Table III.

TABLE III

	1927	1928	1929	1930	1931	1932
Labor, per hr.	40c-50c	40c-50c	40c-50c	45c-50c	45c-50c	35c-40c
6-in. T. C. pipe, per ft.	$0.1155	$0.1097	$0.1108	$0.098	$0.0925	$0.0879
4-in. centrifugal pipe, Class 50, per ft.	.....	.....	.....	0.31	0.28-0.30	0.25

In the above table it will be noted that the cost of labor and terra cotta pipe were less in 1932 than in the preceding five years, and the only item appearing in the table to offset this reduction is the increased quantity of centrifugally cast pipe used as a substitute for terra cotta pipe. Nevertheless two other factors have entered into the cost of sewer house connections in our district which more than offset the reductions in cost appearing in the table. These are, first, the planning of wider streets in new subdivisions than formerly were required, thereby increasing the length of the connection, and, secondly, an increase in the number of connections being constructed in paved streets.

It is my firm belief that a sewer house connection constructed of light weight cast iron pipe and fittings, from the main sewer to the property line or through to the house, with joints of leadite, mineralead, sulphur compound and lead, provides a cheaper service in first cost; one at least as durable, if not more so, than can be secured with any of the other types of pipe commonly used for this purpose. And most certainly produces a service lower in maintenance cost.

Acknowledgment.—The above has been condensed from a paper read before the Maryland-Delaware Water and Sewage Works Association, May 5, 1933.

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Frank Hannan, Honored Abroad in Recognition of His Work as Chief Abstractor of the A. W. W. A.

In recognition of the benefits rendered, in the nature of advancement of water works interests in all countries, by the Abstracts published in the Journal of the American Water Works Association, Frank Hannan, Chemist at the Toronto Filtration Plant and Chief Abstractor of the A. W. W. A., has been made an Honorary Member of the Water Chemistry Section of the Verein Deutscher Chemiker.

The German Chemical Society meets this year at Wurzberg, and an invitation to American chemists and water works men is extended, with the hope that some may be in Europe at the time and could arrange to attend.

MEETING OF THE ILLINOIS SECTION OF AMERICAN WATER WORKS ASSOCIATION

By JOHN R. BAYLIS
Associate Editor

THE Illinois Section of the American Water Works Association held its twenty-fifth annual meeting in Rockford, Ill., at the Hotel Nelson, April 19 and 20, 1933. There were approximately 100 in attendance. Members of the Southern and Central Illinois Conference of Water Treatment Plant Operators, and the West Shore Water Producers' Association were invited to attend, and a fair representation of these organizations was present.

The following were elected to office for the ensuing year:

Chairman—J. J. Woltman, Consulting Engineer, Bloomington, Ill.

Vice Chairman—Lewis I. Birdsall, General Chemical Co., Chicago, Ill.

Treasurer—Alfred E. Skinner, Pitometer Co., Chicago, Ill.

Trustee—Harold E. Babbitt, University of Illinois, Urbana, Ill.

Section Director—W. R. Gelston, Superintendent Water Works, Quincy, Ill.

Technical Sessions

Fifteen technical papers were presented at the four sessions, with most of the papers receiving some discussion.

Some Geological Conditions Governing Location, Drilling, and Casing of Wells. M. M. LEIGHTON. The areas of bedrock wells in Illinois were described. The northern area, which is the most important, embraces approximately one-third of the state. In this section the deeper wells obtain their water from the sandstone beds at depths ranging from 580 to 2,800 feet. In addition to the bedrock areas there are numerous types of glacial deposits which are very important as groundwater reservoirs. Probably the most important are the valley trains. They represent gravel and sand fillings in existing or former valleys. The glacial deposits present no troublesome problems in the drilling of wells. Quicksand has caused some trouble. Most of the bedrock strata present no unusual difficulty. The St. Peter sandstone offers many perplexing problems. Many drilling tools have been lost as a result of the drilling's packing in around the tools. In many wells it is desirable to place a layer of cement between the casing and the walls of the hole to prevent the passage of upper waters downward to deeper water. The glacial drifts are always cased off in the construction of deep wells.

Well Sterilization. C. C. ABPLANALP. There are about 17 per cent of untreated ground water supplies whereas there are only about 2 per cent of untreated surface supplies. The causes of pollution of well-water supplies are adjacent rivers, contamination through abandoned wells, sewers, faulty well casing, crevices through limestone, and surface pollution of shallow wells. One state found that only 25 per cent of the ground water supplies had a perfect record of a year or more. An account was given of outbreaks of water borne diseases at Fond du Lac, Wis.; Bad Axe, Mich.; Salem, Ohio; Helena, Mont.; Santa Ana, Calif.; Lansing, Mich., and other cities caused from polluted well water supplies. Previous to the chlorination of its well supply, one city had an average of 15 typhoid deaths per year, which was reduced to 4 deaths after chlorination. A number of illustrations of how polluted water got into well waters were shown.

C. H. SPAULDING stated there was a reduction in the typhoid at Bloomington, Ill., after chlorinating the well water.

Psychological and Physiological Consideration of Obstacles in Municipal Water Treatment. H. F. FERGUSON, M. S. SABIN, and C. W. KLASSEN. Many people believe that the mineral quality of the water they drink has a very important bearing on their health. There is little to show that the general health of a community where the water contains certain minerals is any better than a neighboring community that does not have these minerals. Many people object to chemical treatment of their drinking water supply because of belief or fear that some of the beneficial minerals in the water will be removed, or because they think that certain chemicals will be introduced which will prove detrimental to health. Some of the absurd claims of the health-giving qualities of mineral waters were related. They ranged from curing granulated eye-lids to rejuvenating humanity. Many of the claims for cures have been investigated by the American Medical Association and in a number of instances the claims have been declared fraudulent and the companies fined. One glass of milk contains the calcium equivalent of 15 glasses of a typical Illinois ground water. In order to obtain the mineral equivalent contained in the ordinary plate lunch of meat, potatoes, peas, lettuce, milk, bread and pie, it would be necessary to drink approximately 60 quarts of this average water. The paper was discussed by Lewis I. Birdsal, George B. Prindle, A. M. Buswell, and C. S. Gill.

Treating Well Waters for Softening, and Iron and Manganese Removal. A. M. BUSWELL. The data on soap consumption which was given in a previous published paper has been checked and found to be correct. Softening by the addition of lime to water was discovered about 100 years ago. Progress in softening water for industrial uses has been fairly rapid, but not so fast in the municipal field. The introduction of zeolites was another step forward in the treatment of waters for industrial uses. The water in municipal plants usually is softened to about 75 to 100 p.p.m. When there is iron in solution in ground water it does not contain dissolved oxygen. To satisfy the requirements for oxidation of iron and manganese very little oxygen is required. A manganese removal plant in Berlin, Germany, has a closed system, and enough oxygen for oxidation is added in the form of pure oxygen gas.

Meeting Emergencies in Water Works. ARTHUR E. GORMAN. Emergencies may be divided into two groups—those resulting from so-called Acts of God, and those resulting from acts of man. The former,

while uncontrollable, can in most cases be anticipated. A list of the various causes for emergencies was given. The water works officials should study the characteristics of the water and be prepared to meet the changes which occur naturally in the water. The promoters of a new water system have an obligation to the public to provide proper funds for a satisfactory plant, and the designing engineer has an obligation to these officials to design along sound engineering lines. The man who undertakes to operate a water works system which, beyond a reasonable doubt, is subject to breakdown jeopardizing life and property, is a simpleton who risks his reputation, his life and self respect. There are two important public checks against faulty water works design—the Boards of Fire Underwriters, and the Departments of Public Health. Some of the more important emergencies occurring in public water supplies were mentioned. C. W. Klassen and C. S. Gill told how some of the emergencies were met, such as the tornado at Murphysboro.

Ammonia-Chlorine Treatment at Champaign-Urbana, Ill. FRANK C. AMSBARY, JR. The paper gave a description of the troubles caused from iron bacteria growths (crenothrix and spyrophyllium) in the distribution system and how the trouble was remedied by use of ammonia in connection with the chlorine treatment. After the plant was put into operation the luxuriant growth of iron bacteria in the sand beds almost prevented flow through the beds. This trouble was remedied by use of chlorine. The free ammonia in the water as it comes from the wells is about 5 p.p.m. The ammonia-chlorine treatment was started in July, 1931. The original dosage was 0.6 p.p.m. of chloramine, which was later increased to 1.2 p.p.m. The ratio of ammonia to chlorine was 1½ to 2. Satisfactory residuals were found throughout the distribution system. Later the ammonia treatment was changed to the clear well, leaving the chlorine treatment in the influent water to prevent growths in the filter beds. The procedure seems to be satisfactory in every respect.

Ammonia-Chlorine Treatment in Danville, Ill., Inter-State Water Co. H. W. ELY. The ammonia is introduced in the suction of the raw water pump and the chlorine is introduced in the discharge. The water passes through a settling basin of about 10.5 hours' detention. Greater amounts of ammonia and chlorine were used at first because the filter beds took up the ammonia and chlorine. A ratio of one of ammonia to four of chlorine was found to be most satisfactory. Not much was expected in taste and odor reduction, and the reason for using ammonia is to prevent after-growths and to produce continued sterilization in the distribution system.

George B. Prindle, in discussing the papers on the ammonia-chlorine treatment, stated he was surprised at the high residuals which could be carried without causing taste. A residual above 0.1 p.p.m. at Highland Park, Ill., was noticeable. C. C. Abplanalp stated that a residual of 3.0 with ammonia could not be detected at Mendota.

Using Perspective in Purification Expenditures. GEORGE B. PRINDLE. The items which go to make up the cost of purifying and pumping water were discussed. Assuming average conditions, the estimated operating cost per million gallons is as follows:

Raw water pumpage	$ 2.02
Alum	2.68
Ammonia	.25
Chlorine	.23
Carbon	1.40
Wash water	.28
Clear water pumpage	11.44
Labor for all purposes	20.00
Heat, light, supplies, etc	2.00
Total	$40.30

The total purification cost exclusive of labor is only about 12 per cent of the total operating expense, and there is no excuse for sacrificing quality for saving in the purification cost.

How to Make Odor Tests. OSCAR GULLANS. A refined method of making odor determinations was described and demonstrated. The intensity of the odor is determined, and then the threshold point is found by dilution with odor-free water. It is very important to have dilution water free from compounds which, if present in higher concentrations will produce odor. An activated carbon unit for preparing odor-free water was described. A 250 c.c. portion of the water to be tested is added to a 500 c.c. flask, the flask covered with a watch glass, the air and water within the flask thoroughly mixed, and the odor test made by inhaling the air inside of the flask through a glass nose-piece. The nose-piece is about seven-eights inch in diameter and 7 to 8 inches long. It is flared at one end and ground to fit the nose of the person who is to use it. All air entering the nostrils must pass through the nose-piece, and in this manner the air from the inside of the flask can be drawn into the nostrils with practically no dilution from the surrounding air. The method is fully twice as sensitive as tests made without the nose-piece.

Discussion on the Use of Activated Carbon. JOHN P. HARRIS gave an interesting discussion of the methods of applying powdered carbon to water. C. S. Gill said that activated carbon was used continuously at Carbondale, Ill., though at times when the taste and odor were not very pronounced the carbon was applied to the water for a certain period after washing the filters, then it was cut off until the filters were washed. This seemed to give satisfactory results. George B. Prindle stated that powdered activated carbon materially reduced the taste and odor at Highland Park, Ill., but did not remove it entirely with the amount of carbon used. Charles B. Burdick stressed the importance of an accurate procedure for making odor determinations for use in determining the efficiency of taste and odor elimination treatments which have been developed within the past few years. He said that the work of Spaulding, which was given at the last meeting of the Section and the work of Gullans given at this meeting were, in his opinion, the most valuable contributions to the Section within the past few years.

The Rockford Water Supply. DANIEL W. MEAD. This paper, which was presented by Harold W. Mead, gave a very interesting description of the development of the Rockford water supply from its very beginning. In the original supply located on the west side of Rock River near several springs, the water was conveyed to a central basin through tile drains laid in gravel deposits. This was inadequate from the first and river water had to be relied upon when there was considerable demand for water. A

very interesting description of the geological conditions in the Illinois and Wisconsin district was given. It showed the importance of giving careful study to geological conditions in the development of well water supplies. The first well was sunk in 1885, and had a total depth of 1,530 feet. Two additional wells were drilled in 1886, one to a depth of 1,998 feet. The supply from the deep wells was inadequate and tests showed that fully two-thirds of the water supply was drawn from the polluted ground water near the surface. To increase the flow of the wells, they were pumped from a point 90 to 100 feet below the surface. The centrifugal pump, located in a shaft about 80 feet from the surface, was driven by a rope drive from a vertical engine located at the surface. The water is now raised by air lift from wells located at several points in the city.

The Water Works at Wilmette, Ill. J. W. NEMOYER. The new Wilmette filtration plant and pumping station now under construction was described. Money for constructing the plant was borrowed from the R. F. C. There was considerable opposition to locating the station on the site selected for fear that it would constitute a nuisance. In view of the environs every effort was made to avoid detracting from the surrounding developments. The roof of the building will be maintained about even with the top of the bluff along the lake front at this point, and will form a promenade deck with an area about 100 by 275 feet, which will be tiled. The capacity of the plant is 6 m.g.d. Brief description of the design of the plant was given.

Water Softening at Quincy, Ill. W. R. GELSTON, JR. The hardness of the Mississippi River water at Quincy varies from 90 to 220 p.p.m., and averages about 150 p.p.m. The softening plant was constructed as an addition to the old filtration plant, and consists of a chemical house, two paddle type mixing basins, one clarifier, and a recarbonation chamber. The mixing basins are about 17 by 26 feet in plan with a two-blade of 16 feet over-all length, driven at a speed of 9.6 feet per second at the tip. The clarifier is the Dorr circular type, 80 feet in diameter. The plant is operated to reduce the hardness to about 70 p.p.m. No soda-ash is used, and lime only is used for softening. Return sludge is used most of the time, but during the past summer the sludge seemed to give the water a slight musty odor and it was not used until the water got colder on the fall.

Cross-Connections and Plumbing-Fixture Studies. HERBERT L. WHITE. Danger of pollution from cross connections to plumbing fixtures due to decrease in water pressure was stressed. The periods of low water pressure occur more frequent than is generally realized. Most of the dangerous cross connections are made by those who know such connections are dangerous. Persons with training in sanitary engineering have been known to deliberately connect pipes containing drinking water directly to sewage pumps for use in priming the pumps. Back-siphonage may occur through flush valves if the closet bowls should be filled with water above the flush rim caused by clogging of the outlet, or if the closet has a low spud which extends below the normal water level. Drinking fountains with the jet placed below the rim of the fixture may produce contamination if the drain should happen to become clogged. Submerged inlets to tanks, lavatories and other vessels may contaminate the water when the pressure on the pipes drop. Joel I. Connelly stressed the danger of contamination caused from the water being sucked back into the distribution system during periods of low pressure, and gave several instances of known pollution from such source.

Reservoir and Pipe Line Project of Louisville, Ky. CHARLES B. BURDICK. A description of the new 30-million gallon balancing reservoir, and the pipe lines connecting the reservoir with the distribution system was given. The reservoir is expected to maintain a higher pressure over the distribution system during times of heavy demand. The water will flow into the reservoir when the consumption is low and out of the reservoir when it is high, thereby maintaining a more even pumpage load. The reservoir necessitated the construction of larger pipe lines to properly connect it to the distribution system. Sixty-inch and 48-inch reinforced concrete pipes were used. The pipes were pre-cast and cured before laying. A special feature of the pipe line was the joints. The sections of the pipes were 12 feet long. There was very little leakage when the line was placed in operation.

Dinner Meeting. A very delightful part of the meeting was the informal discussion on public relations following the dinner. A number of those present took part in the discussion.

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Fighting Fires with Light

In Beaumont, Tex., not only water but light as well is used to put out fires. The fire department there has a special truck equipped with 16 flood-lighting projectors which produce a total of 11,500 watts of spotlight so helpful in fire fighting and rescue work.

Four 20-in. and one 24-in. 2,500 watt and one 14-in. 1,500 watt floodlights comprise the fixed equipment. The 14-in. projector produces a narrow beam capable of reaching approximately one mile. Though they cannot be removed from the truck, these floodlights can be raised and lowered through a range of 5 ft. by means of telescopic extension standards.

Portable flood-lighting equipment, which comes in handy when the current in a burning structure is shut off and some form of auxiliary lighting is necessary, consists of four 14-in. 500 watt and six 12-in. 250 watt projectors. The 500-watt units are mounted on special collapsible umbrella-type stands convenient for placing on the roofs of neighboring buildings or on the street near a raging fire. The 250-watt units are mounted on wheel bases so that they may run into a burning building.

Each portable projector is equipped with 25 ft. of rubber covered cable, but auxiliary cable consisting of two reels of 200 ft. of No. 8 cable is located in the rear of the truck body. Other reels of No. 10 cable 800 ft. long and No. 14 cable 1,000 ft. long are cut in varying lengths. All cable is equipped with pin connectors the same in size so as to match at any point.

Power supply for the flood-lighting is produced by a Westinghouse portable generator located in the truck body. It has a capacity of 11.5 kw. at 125 volts, a rating of 1,450 r.p.m. and is driven by a model OOA, 3½x4½ 29-hp. Hercules engine through a coupling. A Westinghouse switchboard located on the rear wall of the cab and facing to the front of the truck controls the lighting.

THE WATER SUPPLY OF SPARTANBURG, SOUTH CAROLINA

By R. B. SIMMS[1] and J. K. MARQUIS[2]

SPARTANBURG, the county seat of Spartanburg County, is situated in the Piedmont Section of the state. There is a population of approximately 30,000 inhabitants within the corporate limits of the city. The elevation of Spartanburg is approximately 875 feet above sea level. The territory in the vicinity is rolling, gradually rising in a northwesterly direction twenty mile distant.

Previous to the year 1926, the water supply of Spartanburg was obtained from three sources, namely, Chinquepin Creek, Shoally Creek, and Lawson Fork Creek. The water from Shoally and Lawson Fork creeks was pumped into an impounding reservoir located on Chinquepin Creek. The combined waters flowed, by gravity, from the impounding reservoir to the filtration and pumping plants located nearby.

The need for the selection of a new source of supply was becoming very evident. The increase in population of the city together with the expansion of industry was materially increasing the consumption of water. There was also an increase in population, per unit area, on the drainage area of the small streams, thereby increasing human contamination. Viewing conditions as a whole, it was obvious that the time had arrived to abandon the old source of supply, together with the obsolete plant and equipment, and select a new source.

A detailed survey made of all the available sources of supply showed that the South Fork of Pacolet River was the most suitable. The plant was located on the South Fork, about one half mile above the confluence of the North and South Forks, which form the Pacolet River. At this point, the water passes through shoals for a distance of about 1,200 feet. The site being so ideally adapted for a power development, a dam was constructed at the head of the shoals. The dam was erected of such height that a head of 63 feet was made available and an impounding reservoir holding one and one half billions of gallons resulted.

The Dam and Reservoir

The dam is of the hollow, reinforced concrete type with full concrete apron, having an overall length of 450 feet, a height of 50 feet above normal water surface, and contains 7,200 cu. yd. of concrete.

The drainage area above the dam is approximately 92 square miles. At least 35 per cent of this drainage area is a rugged mountainous region, the area between the mountains and the dam is rolling and a large part of the land is under cultivation. The stream reaches an elevation of 2,000 feet at its source and descends rapidly to an elevation of 1,000 feet near Gowansville, after which it descends more gradually until it reaches an elevation of 775 feet in the impounding reservoir, when the reservoir is full. The distance from the source of the stream to the dam is approximately 25 miles.

Only three small towns are located on the watershed, Campobello with a population of 350, Gowansville with a population of 300, and Gramlin with a population of 200. A fairly accurate census shows that the population per square mile on the drainage area is 22 persons. The population is principally rural, and the character of the development is small farms, with a limited amount of live stock. There are practically no industries on the drainage area.

Twenty-five-Year-Old Cast Iron Pipe Reclaimed and Used on Extension to Bleachery, Spartanburg Water Works, Spartanburg, S. C. (R. B. Simms, One of the Authors of This Article, Is in the Trench Without Coat.)

The water is of such quality that permits of very economical purification treatment. The water is relatively soft and contains no mineral constituents that make treatment difficult. The bacterial quality is very good.

The annual rainfall on the drainage area varies from 48.75 inches at the plant to 64 inches at the source of the stream. Streamflow records reveal that the run-off is relatively high, varying from 15 to 20 inches, or from 30 to 40 per cent.

The Power Plant

The power plant is located a distance of 1,200 feet downstream from the dam. There is a maximum head of 63 feet available at this point. A 78 inch penstock leads from the dam to a differential surge tank located just outside the power plant. At the surge tank, the penstock is divided in two 54-inch branches that supply the two water-wheels. A sluice gate is provided on the 78-inch penstock at the intake, while two hydraulically stop valves are placed in the two branches just prior to the scroll cases of the wheels.

The power plant houses two 750-h.p. water wheels direct connected to 625-k.v.a. generators. These units are of the vertical type. Each wheel is provided with 5,000-ft. pound governors.

These generators furnish power for operating the high duty pumps, the lighting of the plant and grounds, and the power equipment of the filtration plant. All excess power is disposed of to the local power company at our switchboard.

In the power house are located all switchboards and appurtenances that go to make up a flexible installation.

Filter Plant

A modern two-story brick and concrete building houses the filter units and pipe gallery. This building, while durable and substantial, does not contain any elaborate decoration either internally or externally.

The filter plant consists of six filter units of the conventional type, each unit having a daily capacity of 1,000,000 gallons. Underneath the filters is a 750,000

[1]Superintendent, Water Works and Sewerage, Spartanburg, S. C.
[2]Engineer in Charge of Plants, Spartanburg, S. C.

gallon clear well. A laboratory is provided for the daily examination of the water; it is roomy and well lighted. Laboratory materials and apparatus are at hand for all necessary analyses.

In the rear of the filter plant is located two concrete coagulating basins. These basins are designed for a six-hour retention at a six million gallon rate of flow. These basins are preceded by a mixing chamber of the baffled type which provides a 30 minute retention period at the normal rate. The mixing chamber is divided into three sections which make for flexible operation. Water is lead into the filter plant by a 24-inch line connected to the 78-inch penstock. The elevation of the filter plant is such that permits of the water coming in by gravity. This arrangement eliminates low lift pumping, which makes for a more economical production cost of the water delivered to the system.

Pumps and Storage Reservoir

The high duty pumping units are located in the power plant. Three, two-stage, centrifugal pumps, direct connected to 300-h.p. slip ring induction motors, comprise the pumping units. Each unit has a capacity of 3,000

Interior of Spartanburg Water Department's Power Plant. Two 750 HP. Water Wheels Drive Two 625 K.V.A. Generators. Surplus Power Above That Needed for Pumping, Etc., Is Sold to Local Power Company. Average Annual Operating Profit Is $9,719.42.

g.p.m. at a 240-ft. head. The suction of these units takes water from the clear well and discharges into a 24-inch cast iron line leading to the storage reservoir some three miles distant from the plant.

The storage reservoir is a covered basin of concrete construction, 200 feet in diameter and has a storage capacity of 3,000,000 gallons. This reservoir is located on the highest point between the city and the plant. It is 240 feet higher than the pumping units, and is approximately 160 feet higher than the highest point within the limits of the city. The water flows from the reservoir to the city, a distance of 10 miles, through a 27-inch cast iron main. This main has a capacity of 10,000,000 gallons per day. Both the 24 and 27-inch lines have protection against the accumulation of air by the installation of air relief valves placed at all high points along the line.

The plants permit of very economical operation. The operating personnel consists of only five employees. One Engineer in Charge, one operator who is competent to carry out all routine chemical and bacteriological analyses; one operator competent to carry out necessary laboratory analyses, and still one other operator who is an experienced power plant operator, and is also capable of performing the duties of a filter plant operator, and one janitor. It is to be noted that the hydro-electric plant does not increase the operating personnel. No mor employees are required than would be necessary with the water plant alone. Only one operator is on duty at a time and each operator works but eight hours per day.

The cost of the entire development amounted to approximately $1,350,000, of which $395,000 is chargeable to the power plant development. The $395,000 covers the cost of the land for the reservoir, the dam, penstock, surge-tank, power house, and appurtenances.

The good judgment of all parties concerned in the power plant development is reflected in the figures of the following table. This table is a summary of average annual earnings of the power plant for the past six years.

Summary of Operation of the Hydro-Electric Plant of the Spartanburg Water Plant—1927-1932, Inclusive

Construction cost chargeable to Hydro-Electric Development		$395,000.00
Estimated life of plant, 35 years.		
Sinking fund, compounded 4½%	$ 4,846.65	
Interest on investment 4½%	17,775.00	
Insurance, maintenance and repairs	1,500.00	24,121.65
Power sold, 2,357,500 kwh. @ ½c	$11,787.50	
Power used for pumping	19,426.39	
Power saved due to elimination low lift pumping	2,627.18	33,841.07
Average annual profit		$ 9,719.42

Note: The power used for pumping, 1,495,054 kilowatt hours, is charged at a rate of $12.99 per thousand, the rate that would be paid for power if it was purchased.

The officials of the Spartanburg Water Works are three Commissioners of Public Works, W. W. Griffin, chairman, D. W. Hendrix and Floyd L. Lyles, Superintendent, R. B. Simms, L. I. Gregory, Secretary and Treasurer. J. K. Marquis is Engineer in Charge of Plants.

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Association Meetings Scheduled

June 9-10—**New York Sewage Works Association.** Hotel Seneca, Rochester, N. Y. Secretary, A. S. Bedell, % State Dept. of Health, Albany, N. Y.

June 12-16—**53rd Annual Convention of the American Water Works Association.** Hotel Sherman, Chicago, Ill. Secretary, B. C. Little, 29 West 39th Street, New York, N. Y.

June 21-22—**Illinois Association of Sanitation Districts.** Galesburg, Ill. Secretary, G. H. Radebaugh, Mgr., Urbana Sanitation District, Urbana, Ill.

June 26-30—**American Society of Testing Materials.** Chicago, Ill. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

June—**Virginia Water and Sewage Works Association.** Newport News, Va. Secretary, H. W. Snidow, % State Dept. of Health, Richmond, Va. (Exact date not set.)

Sept. (?)—**Central States Section American Water Works Association.** Hotel Pantlind, Grand Rapids, Mich. Secretary, B. J. Lechmer, City Water Commission, Erie, Pa.

Sept. 5-7—**Pennsylvania Sewage Works Association.** State College, Pa. Secretary, L. D. Matter, Kirby Health Center, Wilkes-Barre, Pa.

Sept. 7-9—**Pennsylvania Water Operators Association.** State College, Pa. Secretary, I. M. Glace, State Dept. of Health, Harrisburg, Pa.

Sept. 25-27—**American Society Municipal Engineers.** Milwaukee, Wis. Secretary, C. W. S. Sammelman, 4359 Lindell Blvd., St. Louis, Mo.

October 9-12—**American Public Health Association.** Indianapolis, Ind. Executive Secretary, Dr. Kendall Emerson, 450 Seventh Ave., New York City.

A NEW METHOD OF CONCENTRATING ACTIVATED SLUDGE

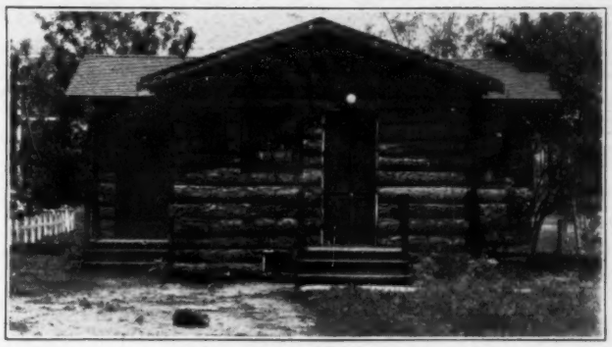
By R. F. GOUDEY[1] and S. M. BENNETT[2]

AT the Griffith Park Sewage Experimental Station of the Los Angeles Department of Water and Power, the writers have developed a new process of concentrating activated sludge which may interest sewage works operators. The sludge is easily concentrated to contain 5 per cent solids. The method employed is simple and can be adopted easily at other plants to greatly reduce the volume of activated sludge, whether the final disposition is to sand beds, digestors or dewatering by vacuum filtration prior to drying or incineration.

The process entails withdrawal or excess activated sludge to be taken out of the system in the form of mixed sewage and sludge from the main aeration tanks rather than from the final settling tanks as is usually practiced. This mixture is allowed to settle in a continuously operated clarifier designed on a basis of 600 gallons per square foot surface area per day. The inlet to the clarifier is at the side and influent enters at the bottom. The overflow liquor from this excess sludge clarifier is equally as good as the final effluent from the conventional final clarifiers and is mixed with the latter. A chlorine dose is applied to the top water of the clarifier to maintain a residual of 1 p.p.m. of chlorine in the water above the sludge zone. This dose amounts to about 25 lb. per million gallons of sewage treated. The residual chlorine carried by the overflow liquor is sufficient to disinfect the final effluent from the entire plant and where final disinfection is employed the residual chlorine does double duty. The thick concentrated sludge is pumped but once daily from the thickening tank without stopping the inflowing aerated mixture containing the excess activated sludge. The process is a continuous one and the thickening tank remains full at all times.

[1]Director Sanitary Engineering Division, Department of Water and Power, Los Angeles.
[2]Chief Operator Griffith Park Experimental Station, Los Angeles.

Experimental Sewage Treatment Plant of Los Angeles, Calif. Point of Chlorination in Sludge Concentration Clarifier Is Indicated by Hose Lying on Board to Right. Sludge Enters at Bottom of Tank.



Field Laboratory, Experimental Sewage Treatment and Recovery Station, Los Angeles, Calif.

The volume of activated sludge in this form is much less than can be obtained by any other known practical method. The average water content after nine months of operation is 94.80 per cent.

Success with this new method of sludge concentration is due primarily to maintaining the presence of the dissolved oxygen which the aerated mixture contains upon entering the thickening tank, but without chlorination would soon be consumed by the organisms. The use of chlorine is equally essential during warm weather to keep the sludge down. The deep inlet likewise has merit. The objection to sludge rising and producing scum, with foul water between the scum and the sludge blanket,—a common and serious fault with the decanting method of concentration—has been completely overcome by the new process. Still further reduction in sludge volume has been obtained by the addition of inert materials for the purpose of weighing down the sludge. Ground oyster shell, decomposed granite, magnesite and other material have been added and moisture contents of the resulting sludge as low as 76 per cent have been obtained. In fact, sludge too thick to be pumped has been secured with this combined process.

Results from the additions of inert materials to accelerate sedimentation and concentration of fresh and activated sludges will be described at a later date. At the present time work is being centered on obtaining concentrated activated sludge with a water content of about 90 per cent by the use of very moderate amounts of ground oyster shell. This attainment is of especial value where the sludge is dewatered by vacuum equipment, whereas concentration without inert materials suffices where the sludge is pumped to a digestor.

Comparison of Previous Methods with the New

Two previous methods of sludge concentration at the Griffith Park Experimental Station embraced decanting clear water, usually in the mid-zone, from thickening tanks operated on a fill and draw plan. The second method was that of pumping all excess activated sludge to the primary crude sewage clarifier at a rate proportional to the solids in the raw sewage. The first method was abandoned in favor of the second, which, in turn, has been displaced by the new method. Table I indicates a comparison of these processes of concentration.

The principal advantage from the new process is felt when the excess activated sludge carries but 1,000 lb. of dry solids per million gallons of sewage treated and also when the sludge is bulked. During such periods the volume of sludge pumped to the digestor, when activated sludge has been pumped to the crude sewage entering the primary clarifier, reaches 9,000 gallons per million gallons as compared with the 5,440 gallons noted in the table for normal sludge. The corresponding figure for the volume of fresh sludge plus the activated sludge

TABLE I

CONCENTRATION OF EXCESS ACTIVATED SLUDGE BY (a) DECANTING, (b) PUMPING TO CRUDE SEWAGE ENTERING PRELIMINARY CLARIFIER, AND (c) THICKENING AERATION TANK LIQUOR WITHOUT USE OF INERT MATERIALS.

Item	(a) *Decantor*	(b) *Clarifier*	(c) *Thickener*
Excess activated sludge (gallons per m.g.)	16,910	16,910	60,000[1]
Concentrated act. sludge (gallons per m.g.)	5,700	2,400	1,600
Per cent reduction in volume	66.4	85.8	90.5[2]
Gallons of conc. sludge per lb. of dry solids	5.5	3.1	2.3
Per cent water in conc. activated sludge	97.73	94.42[2]	94.80
Total fresh and activated sludge to digester (gallons per m.g. sewage treated)	18,300	5,440	4,600

[1]Aeration tank liquor.
[2]Corrected for equivalent volume of returned sludge.
[3]Mixture of crude solids and excess activated sludge.

concentrated by the new process under like conditions is only 5,730 gallons per million gallons. This represents a 36 per cent reduction in volume during sludge bulking as compared with 15 per cent reduction under average conditions. It is during periods of bulked sludge that the sludge concentration and handling problems become most serious.

At the Griffith Park plant it has been found desirable in the interest of economy to dewater fresh (crude) sludge separately from concentrated activated sludge. The sludge cakes from the filter which contain 70 per cent or less water are mixed and subjected to thermoplylic digestion in Becarri cells. This process eliminates the digestor with its attendant problems or supernatant overflow liquor, the drying of digested sludge and the collection of gas. The new process of activated sludge concentration serves admirably in connection with this scheme also.

The Griffith Park Experimental Station has been operated under the direction of H. A. Van Norman, Chief Engineer, and Dr. Carl Wilson, Director of Sanitation of the Department of Water and Power—the senior author* having direct supervision over experiments and operation.

*NOTE.—Mr. Goudey has recently been appointed Director of Sanitation and Laboratoreis for the Department of Water Supply —Dr. Wilson having resigned.—EDITOR.

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Keeping Filter Sand and Gravel Clean

By W. H. LOVEJOY

Superintendent of Filtration, Louisville, Ky.

THEORETICALLY, routine filter washing methods should keep filter sand and gravel clean. Practically, however, we frequently find that the usual washing methods leave much to be desired in this respect. For this reason, auxiliary cleaning methods must frequently be utilized to supplement the regular washing, if the filter bed is to be maintained in a clean condition.

If the routine filter backwash were perfectly efficient, we could expect that all sand and gravel coatings composed of organic matter, clay, aluminum hydrate and manganese and therefore, all mud balls, mud spots and sand cracks in filters would be absent. However, we know from experience that, even with the use of the best practice in filter washing, these difficulties will still persist to varying degrees in different plants.

The effectiveness of the routine filter washing process depends, to a great degree, upon the following details of design and operation:

(a) *The Underdrain System:* Adequate design of the underdrain system makes for uniform distribution of wash water to all parts of the bed, which is a fundamental requirement. Poorly designed underdrains manifest themselves in the form of "dead spots" in the sand bed while washing. These dead spots eventually grow into hard mud spots which are difficult to remove.

(b) *Freeboard:* If the freeboard in a filter (distance from sand surfaces to trough weir) is more than 24 inches, a normal wash water rise will be insufficient to carry over all of the accumulated matter and poor washing results, followed by gradual coating and mud-balling of the sand.

(c) *Insufficient Wash Water Rise:* This eventually results in the same trouble as excessive freeboard, that is, in ability to carry over into the troughs the solids that should be removed from the sand.

A wash water rise of about 22 inches per minute with a water temperature of 32-40 degrees, increasing gradually to a rise of 30-36 inches per minute with water temperature of 70-80 degrees, should be effective in most cases. This approximates a 50 per cent expansion of the sand bed. The high rate of 36 inches can only be used in plants where wash lines, troughs, drains and gravel beds are designed especially to handle it.

(d) *Filter sands that are too fine* introduce difficulties that are hard to overcome. The fine sands rise higher for the same wash rate than do the coarser sands. Thus, the fine sands tend to wash over at high wash rates. Fine sands also tend to coat more quickly and pack together, forming cracks on the surface and at the walls.

AUXILIARY SAND CLEANING METHODS

(a) *Prechlorination treatment,* intermittently applied when necessary, will remove coatings of an organic nature from sand and gravel. At the Lousiville Plant this has been found effective when the chlorine is applied at the rate of 10-12 lbs. per million gallons and treatment is continued until a maximum residual appears and persists in the filter effluent.

(b) *Caustic soda* treatment has been found to be only partially effective and it entails more trouble and expense than the chlorine treatment.

(c) *High pressure hosing* of the filter sand gives good results in the removal of sand coatings of clay. Care must be used in this method to prevent the disturbance of the upper gravel layers beneath the sand.

(d) *A regular sand washing machine or a sand ejector* may be used to clean the sand in an old plant where the sand has become heavily coated. In either case, this entails the transfer of the sand from the filter to a storage pile and its return to the filter.

At the Louisville plant about three years ago, 1,200 yards of sand that had been in use for 22 years was quite thoroughly cleaned by ejecting it from one battery of filters to another, a distance of about 400 feet.

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Spring Meeting of the New York Section of A. W. W. A. Postponed

The Board of Trustees of the New York Section of the American Water Works Association have decided to postpone its spring meeting—having but one other meeting in 1933, that being the regular fall meeting. The action was taken in view of the nearness of the Chicago convention, June 12th-16th; and the likelihood that a greater attendance at Chicago would result by cancellation of the New York Section meeting. This announcement comes from R. K. Blanchard, Secretary of the New York Section, care Neptune Meter Co., New York City.

HYDRANT PRESSURE AND FLOW SURVEY AT PORTLAND, ME.

Tests Made Preliminary to Standard Marking of Hydrants

By LEAVITT R. SMITH
Portland Water District, Portland, Me.

AFTER some discussion on standard markings for fire hydrants at the June, 1928, meeting of the Maine Water Utilities Association, President David E. Moulton appointed a committee to study this subject. After several committee meetings with much careful study, and with the approval of the chief engineers of the various fire departments the committee reported.

Committee's Recommendations

That a uniform color marking should be used throughout the state. That the colors be those used on traffic lights; green, yellow and red. Green to signify a capacity of 1,000 g.p.m. or more; yellow, from 500 to 1,000 g.p.m. and indicating that caution should be used; red, less than 500 g.p.m. and care must be exercised not to create a vacuum by breaking the stream with a pumper.

With this system of colors to guide them, it was the thought of the committee that fire departments called from one city or town to another would know at a glance the capacity of any hydrant they might wish to use. The committee's recommendations were accepted by the Maine Water Utilities Association.

The Portland Water District, complying with this recommendation, during the past summer conducted tests on 750 hydrants representing 41 per cent of the hydrants in its entire system preliminary to rating and marking them. These were in ten of the twelve cities and towns to which it supplies water. Each hydrant was tested individually. A static and residual pressure was taken, also a flow test with a pitometer of the type held into the stream by hand. It is expected that the remaining 59 per cent will be tested and rated next summer.

Procedure of Testing and Recording

In the Water District's office there is a recording system, with a card for each hydrant, giving the location and other information. These cards were numbered, starting with number 1 in each city or town and going through to the last card. Then, plans were made of the places tested showing the location of hydrants, gates and mains. Each hydrant shown on these plans was given a number corresponding to that on the cards. The plans were on a scale of 500 ft. to the inch which proved a very satisfactory size for field use.

A book was prepared by ruling the pages in columns. The hydrant numbers were put in this book so that the information obtained at each hydrant could be easily recorded.

The party doing the work consisted of from two to four men, depending on how hard it was to keep catch-basins free, filling in washouts and keeping water from damaging property.

List of Equipment.—The party used two tested pressure gauges registering from 1 to 100 lbs., a hydrant wrench, a gate wrench, a Stillson wrench, two large pieces of canvas 8 ft. by 12 ft. and three 1¼ by 4 inch iron rods. The canvas was used to keep the water from washing out esplanades and lawns.

Testing.—One of the gauges was connected to the hydrant outlet and the other to the hydrant pitometer. When the hydrants were opened wide the pitot gauge usually recorded about two pounds less than the pressure gauge. Inserting the pitot blade into the stream caused the backing up of the flow slightly and accounts for the pressure differences. We have learned that New York and some other places have discontinued the use of hydrant pitometers and rely on pressure gauges only.

The pitot blades cost $3.00 each and if rocks or other foreign matter strike them they are ruined. As many as three blades have been broken testing one hydrant, but on the average one blade will test about 50 hydrants. Since the residual pressure equals the pounds registered on the pitot gauge, we will discontinue the use of the pitometer when we resume our tests.

On long lines of pipe leading to dead ends, it is advisable to start testing at the end nearest the supply. By this practice, dirt or rust in the mains stirred up by the abnormal rate of flow will be kept along with the party.

It is a good practice to locate and test each gate on hydrant branches before the hydrant test is made, thus preparing for a quick and certain shutdown in case something becomes lodged in the hydrant valve or some defect is found in the mechanism of the hydrant. After it was known that the gate could be depended upon the hydrant caps were removed and enough water let through to wash out any sediment lodged in the ports. Then the pressure gauge was attached.

If soft ground existed where the water was to strike, canvas was spread with one end tied to the hydrant. If it became necessary to deflect the water, one edge of the canvas was tied to the tops of the iron rods driven into the ground, in line and diagonal to the flow.

The hydrants were opened wide and flushed until all sign of sediment had disappeared. Then the pitot blade was inserted into the stream and the reading on both gauges taken and entered in the note-book opposite the hydrant number shown on the plan. Any defect in the operation of the hydrant was also noted in its proper place.

It is necessary to open the hydrants wide in order that the pressure will not be reduced by a partially open hydrant valve.

There were places where it was unwise to test the hydrant because of the possibility of property damage. In such cases a static pressure was taken which helped in the subsequent figuring of the flow in the office. It also helps if the hydrants on each side of the one in question has been tested.

A reading of exactly 10 pounds was seldom registered with the hydrant opened wide, even though the requirements were that the deliveries of the hydrants were to be determined with a residual pressure of 10 pounds. By the use of the hydraulic slide rule it is possible to figure what the flow would be at 10 pounds after finding what it was at the pressure actually recorded during the test.

The company manufacturing pitometer gauges furnishes charts reading in equivalent g.p.m. for each pound

registered on the gauge from 1 to 36 inclusive. In addition we prepared a curve for any number of pounds we had to use which was not listed on this chart.

During this work three breaks were caused in the system. One was found to be a thin place in a 6-inch pipe; the second was an old crack in a 6-inch hydrant T; and the third showed an old crack in a 6-inch pipe. It appeared that these places had been waiting for the extra pressure, caused by closing the hydrants, to make them break.

The tabulation of these tests showed very interesting variations in different parts of the system.

Eighty-six per cent of the hydrants in South Portland were rated as Class A (green), while 100 per cent of those in West Falmouth were rated as Class C (red). These are the two extreme cases. Taken as a whole, one-half of the hydrants fall in the green classification; one-third, yellow; and the remainder, red.

Table I is a summary of the districts completed.

TABLE I

City or Town	No. of Green Hydrants	No. of Yellow Hydrants	No. of Red Hydrants	Total	% Green	% Yellow	% Red
So. Portland...	197	27	4	228	86.5	11.8	1.7
Westbrook ...	106	30	28	164	64.7	18.3	17.
Scarboro	19	58	12	89	21.5	65	13.5
Cape Elizabeth.	24	53	12	89	27.5	59	13.5
Falmouth	50	12	0	62	70.6	19.4	0
Gorham	1	27	15	43	2	63	35
Cumberland ...	4	7	23	34	12	20.4	67.6
West Falmouth	0	0	23	23	0	0	100
So. Windham..	1	9	3	13	8	69	23
Great Diamond Island	3	2	0	5	60	40	0
	406	225	119	750	54.1	30	15.9

Ownership and Condition of Hydrants

For a period of years after a hydrant is set, the municipality in which it is set pays a rental fee to the Portland Water District. After this term of years expires the hydrant then becomes the property of that municipality which becomes responsible for the maintenance of it. It is only when the water utility conducts a test that mechanical defects are discovered in some localities where the municipal officials do not properly inspect hydrants.

In one village with a total of 13 hydrants, 7 of them were controlled by the municipal officials, and the others by the Water District. The caps on all but two of the seven had to be hammered and the wrench hammered to remove them. Two men on a wrench could not open these hydrants and had to use a 10 pound hammer on the wrench to start water flowing. From 10 to 15 minutes were required to open each of these hydrants.

Another condition existed in a city adjacent to Portland which slowed up the test considerably. Between 25 and 30 gate boxes on hydrant branches controlled by the city were filled with sticks and stones. After a couple of months an order was passed by the city council for the Water District to clean out these boxes, then the test was completed.

Below is a list of the mechanical parts of the hydrants found out of order. Caps missing, 1; ports to be leaded in, 2; loose valves, 19; stuffing box leaks, 10; valve gasket leaks, 8; gate boxes filled, 45; top sections of gate boxes gone or tipped, 4; gate boxes under concrete road, 4; and gates repaired, 1. Out of 750 hydrants tested 94 or about 13 per cent had some defect. The above figures indicate that the mechanical parts of hydrants should be tested more frequently than is customary practice.

Conclusion

The result of Portland's application of the hydrant marking committee's recommendation shows that the results are valuable and well worth the time and expense required.

The keeping of good records and assembling of necessary apparatus before starting the field work is essential.

The location of each hydrant gate should be known before starting test.

The test should be begun nearest the source of supply and worked toward dead ends. Every hydrant should be flushed until it delivers clear, clean water.

The hydrant pitometer is unnecessary for the residual pressure gauge gives the same results. After this test has been completed the Water Utilities and Fire Departments know that every hydrant and gate is in good working condition, and that all defects have been corrected.

The amount of water available at each hydrant is indicated by its color and both the local and foreign apparatus can work to better advantage than previously.

Acknowledgment.—A paper read before the New England Water Works Association—printed under authorization of the author.

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Water Softening and Purification at Columbus, O.

The following note is taken from the annual report for 1932 of the Division of Water of Columbus, O.:

During the year an average of 29.6 million gallons of water was softened and filtered each day. This represents 98 gallons per capita per day.

The hardness of the water was reduced from an average of 262 parts per million to an average of 85 parts per million. A reduction of 68 per cent.

To reduce the hardness of the water from an average of 262 parts per million to 85 parts per million, 2,994 tons of soda-ash and 7,194 tons of lime were required. The price paid for soda-ash was $23.733 per ton, and the price paid for the lime was $4.03 per ton, making the total cost for soda-ash $71,057.55 and the total cost for lime $28,991.82. The cost of lime, soda-ash, alum, chlorine and coke per one million gallons of water treated amounted to $10.29.

The average turbidity or muddiness of the river water during the year was 76 parts per million, whereas the turbidity of the filtered water was zero. The average color present in the river water was 29 parts per million. By the combined use of lime, soda-ash and alum, the color was reduced in the filtered water to one part per million. A color of one part per million is not noticeable to the consumer.

There were five deaths from typhoid fever during the year 1932, three of which were resident and two non-resident. Figuring the population at 302,000 (State Bureau of Vital Statistics) would give the city a total death rate from typhoid fever of 1.7 per 100,000, a resident death rate of 1.0 per 100,000, and a non-resident death rate of 0.7 per 100,000.

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FINANCING SEWERAGE IN ILLINOIS. A bill has passed the state senate of Illinois and is now before the house authorizing municipalities to improve, construct, acquire and operate sewerage systems and to issue revenue bonds to be retired from revenues derived from the operation of such system. This would take the sewerage system out of the corporate tax fund and put it on a self-sustaining basis, operating on a fee or meter system.

CONVENTION OF THE AMERICAN WATER WORKS ASSOCIATION

Hotel Sherman, Chicago, Ill., June 12-15, 1933

PROGRAM

SUNDAY EVENING—JUNE 11TH.

Meeting of the Board of Directors will be held at 8:00 p. m. in Room 116.

(Members having business to bring before the Board should present it in writing to the Secretary before this meeting.)

MONDAY FORENOON—JUNE 12TH.

8:00—Registration.

10:00—Meeting of the Committee on Water Works Practice.

Main Session, Grand Ball Room

11:00—Opening of Convention.

George W. Pracy, President.

Announcement of officers elected for the year 1933-34. Reports of Secretary, Treasurer and Board of Directors. Action on Budget.

Presentation of John M. Diven Memorial Medal.

Presentation of John M. Goodell Award.

New Business.

MONDAY AFTERNOON

12:30—Dedication of Memorial Plaques to Chicago Water Works Engineers.

Ellis S. Chesbrough—1813-1886.

Dewitt C. Cregier—1829-1898.

John E. Ericson—1857-1927.

At "Old Water Tower," Chicago Avenue and Michigan Blvd. All are invited to attend.

Main Session, Louis XVI Room

Plant Management and Operation Division

Superintendents' Round Table Discussion.

H. F. Blomquist (Chairman), Supt., City Water Works, Cedar Rapids, Iowa.

2:00—"Consumer's Good Will, Its Value and Method of Promotion." Discussion led by Frank C. Jordan, Sec'y, Indianapolis Water Co., Indianapolis, Ind.

"Consumer's Complaints and How to Meet Them." Discussion led by Eugene F. Dugger, Gen. Mgr., Newport News Water Works Commission, Newport News, Va.

"Policies as to Delinquent Water Bills Under Depressing Conditions." Discussion led by M. F. Hoffman, Asst. Supt. in Charge of Commercial Division of Water Works, Cincinnati, Ohio.

"Use of Several Small Meters vs. One Large Meter for Large Services." Discussion led by H. L. Monroe, Supt. of Water Works, Pontiac, Mich.

"Measurement of Small Water Flow." Discussion led by Dale L. Maffitt, Asst. to Gen. Mgr., Des Moines Water Works, Des Moines, Iowa.

"Meeting Unusual Conditions in Water Works Operation." Symposium by various members.

5:00—Meeting of the Board of Directors. Room 116.

TUESDAY FORENOON—JUNE 13TH.

Main Session, Louis XVI Room

9:30—"Some Interesting Phases of Chicago's Water Works Activities"—Myron B. Reynolds, City Engineer, Chicago, Ill.

9:50—Discussion led by L. R. Howson, Alvord, Burdick & Howson, Cons. Engrs., Chicago, Ill.

10:10—"Locating and Eliminating Leakage in Chicago Distribution System"—J. B. Eddy and Bernard Phillips, Bureau of Engineering, Chicago, Ill.

10:30—Discussion led by Fred B. Nelson, Civil Engr., Dept. of Water Supply, Gas & Electricity, New York, N. Y.

10:50—"The Place of Public Works in the Economic Scheme"—Willard T. Chevalier, Publishing Director, *Engineering News-Record*, New York, N. Y.

11:15—Discussion led by Malcolm Pirnie, Cons. Engr., New York, N. Y.

11:30—"Appraisal of a Year's Operation of the Reconstruction Finance Corporation Plan and Its Effect in Aiding Water Works Betterments"—John P. Hogan, Parsons, Klapp, Brinckerhoff & Douglas, Cons. Engrs., New York, N. Y.

11:55—Discussion led by Willard T. Chevalier, Publishing Director, *Engineering News-Record*, New York, N. Y.

TUESDAY FORENOON (Continued)

9:30—Crystal Room. Committee on Boiler Feed Water Studies. Sheppard T. Powell (Chairman), Cons. Chem. Engr., Baltimore, Md.

TUESDAY FORENOON (Continued)

Finance and Accounting Division, Gray Room

C. J. Alfke (Chairman), Comptroller, Hackensack Water Co., Weehawken, N. J.

9:30—"The Centralization-Decentralization Situation in Commercial Activities (Has the depression indirectly solved this question for all times?)"—Carl K. Chapin, Commercial Director, Dept. of Water & Power, Los Angeles, Calif.

Discussion led by Frank C. Jordan, Sec'y, Indianapolis Water Co., Indianapolis, Ind.

10:10—"The Installation of a Modern System of Billing and Accounting in the Chicago Bureau of Water"—(Illustrated by motion pictures)—H. L. Meites, Supt. of Water and Editor of the *Chicago Chronicle*, Chicago, Ill.

Discussion led by Jacob Schwartz, Attorney, New Jersey Public Service Commission, Newark, N. J.

10:50—"Handling of Shop and Yard Supplies and Equipment"—J. S. Dunwoody, Supt., City Water Dept., Erie, Pa.

Discussion led by William A. Weigel, Junior Engr., and Ray Magin, in Charge of Stock Record Section Water Dept., Chicago, Ill.

11:30—"At War With the Depression in the Detroit Water Department"—Hal F. Smith, Supt. of Water Consumers Accounts, Dept. of Water Supply, Detroit, Mich.

Discussion led by A. P. Michaels, Orlando, Fla.

TUESDAY AFTERNOON

Main Session, Crystal Room

2:00—"Introducing Your 'New' Consumer"—Mary Elizabeth Symms, Public Relations Counselor, Indianapolis Water Co., Indianapolis, Ind.

2:20—Discussion led by A. C. Kamplain, Sec'y to the Water Dept. Board of Trustees, Valparaiso, Ind.

2:40—"Special Low-Heat Cement for Mass Concrete Dams"—Samuel B. Morris, Chief Engr., Water Dept., Pasadena, Calif.

3:00—Discussion led by Thaddeus Merriman, Chief Engr., Board of Water Supply, New York, N. Y.

3:20—"Ground-Level Storage and Booster Station at Milwaukee, Wis."—Herbert H. Brown, City Engineer's Office, Milwaukee, Wis.

3:40—Discussion led by Nicholas S. Hill, Jr., Cons. Engr., New York, N. Y.

4:00—"Twenty Years' Progress in Centrifugal Water Works Pumps"—A. Peterson, Chief Engr., Pump Dept., DeLaval Steam Turbine Co., Trenton, N. J.

4:20—Discussion led by R. D. Hall, Mgr., Water Works Dept., Worthington Pump & Machinery Corp., Harrison, N. J.

TUESDAY AFTERNOON (Continued)

Water Purification Division, Louis XVI Room

Joseph W. Ellms (Chairman), Engr., Water Purification & Sewage Disposal, Dept. of Public Utilities, Cleveland, Ohio.

2:00—"Current Research in Water Bacteriology"—J. F. Norton, The Upjohn Co., Kalamazoo, Mich.

2:15—Discussion led by N. J. Howard, Director of Water Purification, Island Filtration Laboratories, Toronto, Ont., Canada.

2:20—General Discussion.

2:30—Report of Committee on "Testing Water Purification Chemicals." M. M. Braidech (Chairman), Senior Chemist, Baldwin Filtration Plant, Cleveland, Ohio.

2:50—Discussion led by R. C. Bardwell, Supt., Water Supply, C. & O. R. R. Co., Richmond, Va.

2:55—General Discussion.

3:05—"Determining the Quality of Zeolites"—H. L. Tiger, Chief Engr., Permutit Co., New York, N. Y.

3:25—Discussion led by Charles P. Hoover, Chemist, Filtration Plant, Columbus, O.

3:30—General Discussion.

3:40—"Proposed Plan for Ammonia Chlorine Treatment at Chicago"—A. E. Gorman and H. H. Gerstein, Bureau of Engineering, Chicago, Ill.

4:00—Discussion led by L. H. Enslow, Editor, *Water Works and Sewerage,* New York, N. Y.
4:05—General Discussion.
4:15—Report of Committee on Control of Tastes and Odors. Martin E. Flentje (Chairman), Westmoreland Water Co., Greensburg, Pa.
4:30—Discussion led by George D. Norcom, Federal Water Service Corp., New York, N. Y.
4:35—Discussion led by Fred E. Stuart, Research Engr., Industrial Chemical Sales Co., New York, N. Y.
4:40—General Discussion.

WEDNESDAY FORENOON

Main Session, Louis XVI Room

9:30—"Manufacture and Laying of Lock Joint Concrete Water Pipe"—F. F. Longley, Lock Joint Pipe Co., Ampere, N. J.
9:50—Discussion led by Charles J. Desbaillets, Chief Engr., Montreal Water Dept., Montreal, Que., Canada.
10:10—"Bituminous Pipe Coatings"—W. M. Wallace and James Parks, Water Dept., Detroit, Mich.
10:30—Discussion led by E. V. Rinehart, Johns-Manville Corp., New York, N. Y.
10:50—"Water Pipe Electrolysis Caused by Promiscuous Grounding of Electric Lines"—Nicholas S. Hill, Jr., Cons. Engr., New York, N. Y.
11:10—Discussion led by Charles F. Meyerherm, Albert F. Ganz, Inc., Cons. Engrs., New York, N. Y.
11:30—"Some Modern Methods of Coating and Lining Pipe"—Linden Stuart, Wailes Dove-Hermiston Corp., New York, N. Y.
11:50—Discussion led by Leslie W. Stocker, Senior Civil Engr., Utilities Commission, San Francisco, Calif.

WEDNESDAY FORENOON (Continued)

Finance and Accounting Division, Crystal Room

C. J. Alfke (Chairman), Controller, Hackensack Water Co., Weehawken, N. J.
9:30—"A Fixed Property Record Form and Its Use." (Discussed from the standpoint of rate case data, substantiating overheads, supplying tax data, and recording property for insurance purposes, etc.)—Jacob Schwartz, Attorney, New Jersey Public Service Commission, Newark, N. J.
Discussion led by Joseph Gill, Certified Public Accountant, New York, N. Y.
10:10—"State Regulation of Water Rates for Municipal Water Plants"—A. Bliss McCrum, Sec'y, Public Utilities Association of West Virginia, Charleston, W. Va.
Discussion led by Samuel B. Morris, Chief Engr., Water Dept., Pasadena, Calif.
10:50—"Commission Regulation of the Issuance and the Accounting Treatment of Security Issues by Municipalities and Private Companies for Water Works Purposes"—David E. Lillenthal, Member of Public Service Commission of Wisconsin, Madison, Wis.
Discussion led by John H. Murdoch, Jr., Attorney-at-Law, Washington, Pa., and Pres., Pennsylvania Water Works Association.
11:30—"Taxation as Affecting Operating Costs of Private and Municipal Utilities"—Charles J. Tobin, Attorney-at-Law, Albany, N. Y.
Discussion led by Louis D. Blum, Certified Public Accountant, New York, N. Y.

WEDNESDAY AFTERNOON

Main Session, Crystal Room

Symposium on Cement Lined Water Mains

2:00—Introductory Statement—L. P. Wood, Designing Engr., Board of Water Supply, New York, N. Y., and Chairman of Technical Committee 3 on Corrosion and Protective Coatings of the Sectional Committee on Specifications for Cast Iron Pipe.
2:15—"Results Obtained from Cement Lining." Discussion led by T. H. Wiggin, Cons. Engr., New York, N. Y., and James E. Gibson, Mgr. and Engr., Water Dept., Charleston, S. C.
2:30—"Cutting, Tapping, Handling, Etc." Discussion led by Reeves J. Newsom, Pres., Community Water Service Co., New York, N. Y.; James E. Gibson, Mgr. and Engr., Water Dept., Charleston, S. C., and T. H. Wiggin, Cons. Engr., New York, N. Y.
2:45—General Discussion.
2:55—"Separation and Cracking of Lining." Discussion led by T. H. Wiggin, Cons. Engr., New York, N. Y.; W. R. Conard, Cons. Engr., Burlington, N. J.; Reeves J. Newsom, Pres., Community Water Service Co., New York, N. Y.; D. B. Stokes, Vice-Pres., United States Pipe & Foundry Co., Burlington, N. J.; H. Y. Carson, Director of Research, National Cast Iron Pipe Co., Birmingham, Ala.; W. D. Moore, Pres., American Cast Iron Pipe Co., Birmingham, Ala.
3:30—General Discussion.
3:45—"Solubility of Lining." Discussion led by Robert Spurr Weston, Cons. San. Engr., Boston, Mass.; George D. Norcom, Federal Water Service Co., New York, N. Y.; Martin E. Flentje, Westmoreland Water Co., Greensburg, Pa.; E. L. Chappell, National Tube Co., Pittsburgh, Pa.; D. B. Stokes, Vice-Pres., United States Pipe & Foundry Co., Burlington, N. J.
4:10—General Discussion.
4:25—"Lining Fittings." Discussion led by Wm. W. Brush, Chief Engr., Dept. of Water Supply, Gas & Electricity, New York, N. Y.; T. H. Wiggin, Cons. Engr., New York, N. Y.; D. B. Stokes, Vice-Pres., United States Pipe & Foundry Co., Burlington, N. J.
4:40—General Discussion.
4:45—"Full Thickness of Lining at Ends." Discussion led by Reeves J. Newsom, Pres., Community Water Service Co., New York, N. Y.; T. H. Wiggin, Cons. Engr., New York, N. Y.; D. B. Stokes, Vice-Pres., United States Pipe & Foundry Co., Burlington, N. J.
4:55—General Discussion.
5:00—"Exterior Coating." Discussion led by Wm. W. Brush, Chief Engr., Dept. of Water Supply, Gas & Electricity, New York, N. Y.; D. B. Stokes, Vice-Pres., United States Pipe & Foundry Co., Burlington, N. J.
5:10—General Discussion.

WEDNESDAY AFTERNOON (Continued)

Water Purification Division, Louis XVI Room

Joseph W. Ellms (Chairman), Engr., Water Purification & Sewage Disposal, Dept. of Public Utilities, Cleveland, Ohio.
2:00—"The Removal of Aggressive Carbon Dioxide by Contact Beds of Limestone"—Charles R. Cox, Assoc. Engr., State Dept. of Health, Albany, N. Y.
2:15—Discussion led by Malcolm Pirnie, Cons. Engr., New York, N. Y.
2:25—General Discussion.
2:30—"Disposal of Lime Sludge at Water Softening Plants"—W. H. Dittoe, Chief Engr., Mahoning Valley Sanitary District, Youngstown, Ohio.
2:45—Discussion led by Thomas R. Lathrop, Asst. San. Engr., State Dept. of Health, Columbus, Ohio.
2:55—General Discussion.
3:00—Report of Committee on Filtering Materials. John R. Baylis (Chairman), Physical Chemist, Bureau of Engineering, Chicago, Ill.
3:15—Discussion led by James W. Armstrong, Filtration Engr., City Water Dept., Baltimore, Md.
3:30—General Discussion.
3:40—"Control of Manganese and Iron Accumulation in Filter Sand"—Paul W. Frisk, Chem. Engr., Chief of Chem. Laboratory, American Enka Corp., Enka, N. C.
3:50—Discussion led by Robert W. Sawyer, Asst. Engr., with Malcolm Pirnie, Cons. Engr., New York, N. Y.
3:55—General Discussion.
4:00—"A New Direct Plating Medium Specifically Selective for B. Coli."—Fred O. Tonney, Director of Laboratories & Research, Dept. of Health, Chicago, Ill., and Ralph E. Noble, Prin. Bacteriologist, Dept. of Health, Chicago, Ill.
4:15—Discussion led by Jack J. Hinman, Jr., Assoc. Prof. of Sanitation, University of Iowa, Iowa City, Iowa.
4:20—General Discussion.
4:30—Election of Officers.

THURSDAY FORENOON

Main Session, Louis XVI Room

Plant Management and Operation Division.

Superintendents' Round Table Discussion. H. F. Blomquist (Chairman), Supt., City Water Works, Cedar Rapids, Iowa.
9:30—"Quick Closing Valves for Isolating Breaks in Large Mains." Discussion led by Wm. W. Brush, Chief Engr., Dept. of Water Supply, Gas & Electricity, New York, N. Y.
"Value of Continuous Pressure Recorders in Various Parts of Distributing System." Discussion led by Justus B. Eddy, Engr., Water Pipe Extension, Chicago Water Works, Chicago, Ill.
"Inspection and Control of Sprinkler Systems and Other Special Connections." Discussion led by J. Arthur Jensen, Supervisor, Water Works Dept., Minneapolis, Minn.
"Control of Sizes of Consumer's Services." Discussion led by Wallace W. Morehouse, Director, Dept. of Water, Dayton, Ohio.
"Selection of Service Pipe Material Under Present Prices." Discussion led by Walter A. Peirce, Mgr., Water Dept., Racine, Wis.
"Water Works Construction as Unemployment Relief." Symposium by various members.

THURSDAY AFTERNOON

Joint Session of General Membership and Water Purification Division, Louis XVI Room

2:00—"The Economic Effects of Quality of Water with Special Reference to Soap Consumption"—H. W. Hudson, University of Illinois, Urbana, Ill.

2:15—Discussion led by A. M. Buswell, Chief, State Water Survey Division, Urbana, Ill.

2:20—General Discussion.

2:30—"Progress in Water Purification"—George W. Fuller, Cons. Engr., New York, N. Y.

2:50—Discussion led by John R. Baylis, Physical Chemist, Bureau of Engineering, Chicago, Ill.

3:00—"Industrial Water Purification Research"—Sheppard T. Powell, Cons. Chem. Engr., Baltimore, Md.

3:15—Discussion led by Clarence R. Knowles, Supt., Water Service, Illinois Central Railroad, Chicago, Ill.

3:20—General Discussion.

3:30—"The Work of the State Sanitary Engineer"—Ellis S. Tisdale, Director, San. Engineering Division, State Dept. of Health, Charleston, W. Va.

3:45—Discussion led by L. H. Enslow, Editor, *Water Works and Sewerage*, New York, N. Y.

3:50—General Discussion.

4:00—"The Public Relations Value of the Water Works Laboratory"—Harry E. Jordan, San. Engr., Indianapolis Water Co., Indianapolis, Ind.

4:15—Discussion led by I. M. Glace, Dist. Engr., State Dept. of Health, Harrisburg, Pa.

4:20—General Discussion.

THURSDAY AFTERNOON (Continued)

4:30—Room 116. Board of Directors.

FRIDAY

"Water Works Day" at the Century of Progress Exposition.

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William W. Brush, Chief Engineer, Department of Water Supply, Gas & Electricity, Municipal Building, New York, N. Y.

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Editor

Abel Wolman, Chief Engineer, State Department of Health, 2411 N. Charles St., Baltimore, Md.

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Burt B. Hodgman (Chairman), National Water Main Cleaning Co., New York, N. Y.

Ladies' Entertainment

Exhibit

Guy C. Northrop (Chairman), Hydraulic Development Corp., New York, N. Y.
E. F. Lee, A. P. Smith Mfg. Co., Chicago, Ill.
J. Herman Smith, Hersey Mfg. Co., Boston, Mass.

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William Byrd, Alabama Pipe Co., Chicago, Ill.
Karl M. Mann, *Water Works Engineering*, New York, N. Y.

Publication

Edgar J. Buttenheim, *The American City*, New York, N. Y.

Press

William T. Chevalier, *Engineering News-Record*, New York, N. Y.

EDITORIALS

WE FAVOR:

1. No diversion of water works revenues.
2. Laws permitting a city to issue "revenue bonds" for water works or sewerage improvements.
3. The passage of a "sewer rental law" in every State similar to that in Michigan.
4. Universal metering.
5. Universal treatment of water to secure not merely elimination of harmful bacteria, but freedom from hardness, odors and bad tastes.
6. Cessation of stream and lake pollution.
7. The pension system for municipal employees.
8. Registration or licensing of engineers and operators responsible for design, the approval of design, or the operation of water works, sewerage, and treatment works on either system.
9. Periodic employment of consulting engineers to diagnose any economic troubles and prescribe the cures.
10. Elimination of "politics" from the construction and operation of water works and sewer systems.

Sturdy Sprinkling Filters

AMONG the oxidizing devices employed in sewage treatment practice, the sprinkling filter seems certain to hold its own. These remarkable units stand the hardest sort of punishment—abuse, to the bending point without breaking. Give them half a chance and recuperation is rapid and thorough. The sprinkling filter takes what is given it and makes the best of it. A heavy dose of some trade waste may cause it to shake and shudder for a short period but the shock is thrown off and its efficiency is quickly regained.

Take a look at a few of the remarkable records of existing sprinkling filters. For example: the filters at Columbus, Ohio, have been doing duty these 27 years without any overhauling, notwithstanding the none too good efficiency of the sedimentation tanks ahead of them. During a major part of this period of service these filters have received sewage considerably in excess of the design capacity of 19 million gallons per day. Even now with almost a 100 per cent overloading, and with little or no rest between sprayings, this "wheelhorse" of sewage treatment devices turns out an effluent showing an overall plant efficiency of roughly 70 per cent in terms of oxygen demand removal. Considering, that 85 per cent is a fair removal to expect from normal loadings on 6 foot filters, the 70 per cent removal by 5 foot beds under Columbus conditions is indicative of the sort of punishment that the sprinkling filter can stand up under. There is no other counterpart in the sewage treatment field. Another case is that of the Reading, Pa., filters. Constructed of slag, choked up with sewage solids at one time, allowed to dry out during revamping of the plant, the solids unloaded. And now, after 27 years of service without moving the slag, these units are considered as good as new. Then, there are the Baltimore, Md., filters with 20 years of constant service to their credit. Never having had to be bypassed in these 20 years, and never overhauled, these filters are good for any number of years of additional service.

Good concrete, good stone and cast-iron piping with brass nozzles are almost imperishable and therefore the sprinkling filter with proper care should serve several generations. What's more, the low cost of operation adds to their claims of practibility.

The flexibility of the sprinkling filter is an asset of considerable value. Overloading for moderate periods is not of serious consequence as it is with other processes. Even after an upset, its rapidity of recuperation is something one must marvel at. Even after superchlorination, it recovers its efficiency fully within a few days. Take the case of Barnsley, England: Each summer, with the bio-areation plant failing to stand up under the loading, there has been no question as to what to do. The sprinkling filters take care of the extra loading imposed upon them in the form of sewage diverted to them in order to relieve the less sturdy process.

Chemical precipitation ahead of sprinkling filters has been practiced in England with some degree of success for removing a part of the organic loading. The application of bio-aeration ahead of filters is likewise successful both here and abroad—the process having been first used at Birmingham, England. Reported elsewhere in this issue are the interesting developments at the Plainfield, N. J. sewage works, wherein a unique application of chemical precipitation, involving the use of a ferric coagulant, is proposed to reduce by 50 per cent the loading on the filters, making it possible to produce a sparkling final effluent of phenomenally low organic content without increasing the existing filter area.

The sprinkling filter is a remarkable unit and one can not afford to overlook its added possibilities when employed in conjunction with partial activation or chemical precipitation for reducing required filter area, or as a means of increasing the capacity of existing filters, and for the control of odors and filter fly breeding.

▼

Super Sewerage Service

Here's a new reason as to why it may be profitable to inspect sewers. Of course, it depends upon how you look at it though.

In Elmira, N. Y., U. S. agents found that sewers could be used to convey liquid far less limpid than dish water. Through high pressure hose lines run within the sewers, proprietors of a large distillery had been pumping the finished product from the "factory" to the warehouse about a half mile distant. Through another hose line the "raw materials" were being pumped to the distillery. The by-products naturally went to the sewer which, in all, represents about the most complete sewerage service ever supplied an "industry" by a municipality, and all without charging sewer rental to boot.

Having discovered the hose entering the sewer from the warehouse, it was a simple matter to locate the distillery by tracing the hose lines.

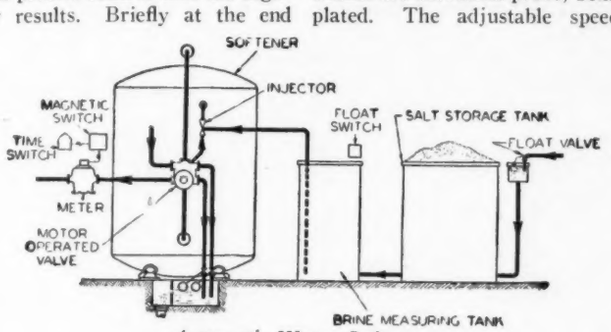
L. H. Enslow

NEW EQUIPMENT AND MATERIALS

Fully Automatic Water Softener Offered by Permutit

The newest thing in water softening is the fully automatic Zeolite water softener which has been developed recently by The Permutit Company of New York City. This softener, shown for the first time at the New York Power Show, eliminates from softening practice errors due to the human element and conducts all of the operations of softening and regeneration with machine-like regularity and precision.

By a clever combination of a meter operated switch and electric controls with a motor driven Permutit single valve, each operation of the water softener is conducted under such precise control that the highest efficiency results. Briefly at the end of the softening run, the meter actuates the electrical controls which carry through the steps of:—(1) Cutting the softener out of operation. (2) Backwashing it for a regulated period so as to secure thorough cleansing. (3) Admitting a carefully regulated amount of saturated salt brine so as to assure thorough regeneration without wastage of salt. (4) Rinsing out the expelled salts of hardness to waste with the minimum amount of rinse water. And, (5) throwing the softener back into service thus placing it again under control of the meter, which governs the volume of water to be softened during the softening run and automatically starts off the next regenerating cycle.



Automatic Water Softener.

New models of softeners are especially to accommodate the full automatic operations and it becomes a relatively simple matter to apply the automatic control to existing downflow softeners, thus converting manually controlled units into full automatic softeners.

Write The Permutit Co., 440 Fourth Avenue, New York City for illustrated literature describing this recent development.

"Tru-Test" Sampler for Sewage and Industrial Wastes

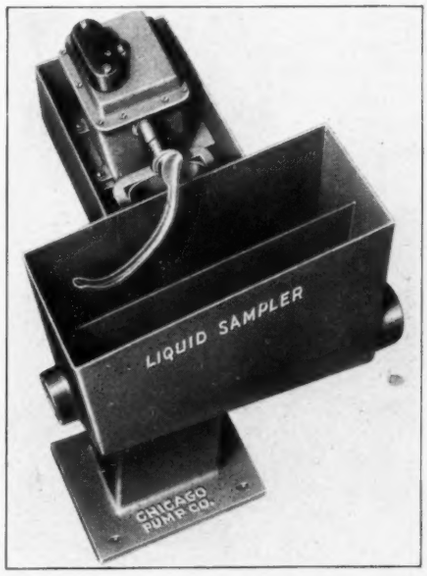
The Chicago Pump Company have added another unit to their line of equipment for sewage treatment plants. This device, known as the "Tru-Test" Liquid Sampler, automatically takes samples at various points in sewage treatment plants in industrial establishments. It is used in conjunction with sewage sludge sampling also,

The speed of this machine can be adjusted to take samples of the liquid every 2, 3, 4 and 5 minutes as desired, assuring an accurate composite sample at the end of the day. The revolving channel-spoon does the work.

It is of sturdy construction, simple in design, and has no complicated parts that require constant attention.

The initial cost is low, and the operating cost is kept at a minimum, requiring only 40 to 50 watts.

The unit is shipped completely assembled, and the revolving sampling "spoon" and funnel are corrosion proof, being chromium plated. The adjustable speed motor is moisture proof and gears are sealed in oil, requiring no further lubrication.

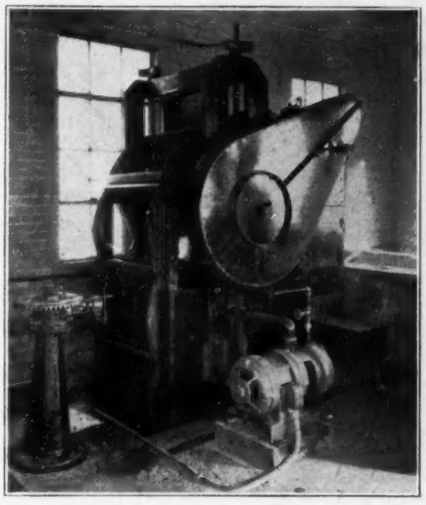


The "Tru-Test" Sampler for Sewage Sludge and Industrial Water.

Simplicity of design and neatness of construction, low initial cost, and low operating costs were the aims achieved by the designer of the "TRUE-TEST" Sampler—Ask the Chicago Pump Co., 2336 Wolfram St., Chicago, for descriptive folders, 28-F. If interested in sludge pumping—ask for folder 128-D also.

Chain Belt Trash Screen Used in Sewage Treatment

Removing debris by screening the water flowing into power plants and water works, has been a common job for Chain Belt Company's traveling water screens, but now one is removing floating material from sewage at the Flint (Michigan) Sewage Disposal Plant. This unusual application has removed a serious obstacle to operating this plant efficiently. Previously, stationary screens were used and these could not be cleaned frequently enough to prevent a large accumulation of debris on them. This retarded the flow of sewage thru the plant and reduced the water level behind the screens sufficiently to stop the operation of the siphons controlling the flow to the filters. Now the REX Traveling Water Screen continuously removes the accumulating debris and allows unrestricted flow thru the plant. An additional advantage has been secured because more, and even smaller, material is now removed. This has prevented stoppages in filter nozzles that was previously a source of annoyance, and expense for a man to clean them frequently. An Allis-Chalmers motor and pump, delivers the screen cleaning water in this installation.



Rex Traveling Screen Adopted to Sewage Treatment at Flint, Mich.

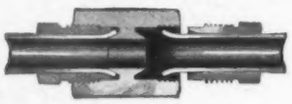
For further details the reader should address Chain Belt Co. of Milwaukee, Wis. —Attention Sanitation Equipment Division.

Bailey Die-Form Fittings and Tubing

Copper tubing now so popular as a material for use in making service connections between the water main and house piping is also being increasingly used for other and varied installations at pumping stations, in filtration plants and at sewage treatment works. The use of flexible copper tubing jointed with compression type

of unions is being more extensively used as a conduit for liquid chlorine or chlorine gas from the chlorine containers located some distance from the chlorine feed equipment.

The "Die-Form" fittings manufactured by the Bailey Meter Company of Cleveland, Ohio, when turned up produce a leak proof connection when used on copper tubing and these fittings create no restrictions and provide the same area as the copper



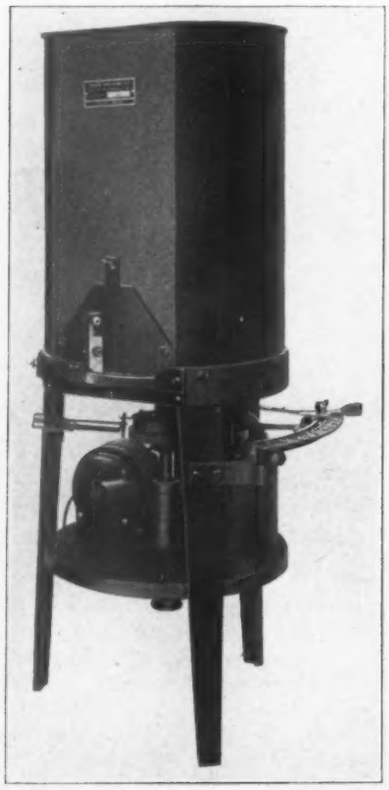
Die-Form Tubing Union.

tubing itself. The use of compression fittings of this type are time saving and offer security of joint not realized with rigid tubing jointing. The joints are vibration proof and offer no problem in contraction and expansion.

In addition to the style of compression union illustrated, the Bailey Meter Company—1050 Ivanhoe Road, Cleveland, O.,—supply many styles of fittings and types of copper tubing. Let them mail you their latest bulletin on "Die-Form" Fittings.

Omega Offers New Dry Feeder

The new Model 1 dry feeder recently announced by the Omega Machine Company of Kansas City, Mo., has been designed primarily for the accurate feeding of small quantities of chemicals—notably activated carbon. Its range of feed lies between 1 and 200 pounds of material per 24 hours. The capacity of the feed hopper is



Model 1 Omega Disc Feeder.

50 pounds of powdered activated carbon "Nuchar" or 150 pounds of hydrated lime. The new feeder is especially designed for accuracy at *all* rates of feed and is instantly adjustable to a different rate of feed without guess-work, according to claims of the manufacturer. There are no delicate or inaccessible and complicated parts to the feeder and all wearing parts are immersed in oil. It makes no noise and according to the manufacturers it creates no dust.

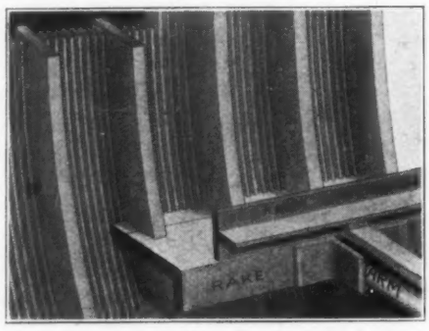
The feeder is motivated by a ¼ H. P. motor turning a horizontal disc, at the bottom of the hopper, which has grooves in its face. The filled groove becomes exposed as it turns and at this point an adjustable scraper removes the material from the groove and allows it to drop into a solution or wetting chamber from which it is discharged continuously to the liquid being treated.

More than 200 speed changes of the disc are available to vary the discharge of chemical at will. A further adjustment of feed may be had by specifying a disc with grooves of two sizes—each with its individual scraper. With such a disc the feeder can be used for compact or fluffy chemicals at will without a change of disc or gearing which reduces the motor speed to that desired for the rotation of the disc.

Descriptive leaflets may be had by addressing the Omega Machine Company, 4010 Penn. Ave., Kansas City, Mo.

Combination Bar and Fine Screen for Sewage Treatment

The Schofield Self-Cleaning Screen introduced into the sewage treatment field by Municipal Sanitary Service Corporation of New York City is available in the form of a coarse screen, fine screen or a combination of both, as shown in the illustration. The combination unit contains heavy bars (½ to 2½ inches apart) for rough



Schofield Self-Cleaning Screen.

screening and intermediate bars (spaced as close as 1/16th inch where desired) for fine screening. A reciprocating rake cleans the stationary bars continuously. The heavy bars are of wrought-iron and the small bars for fine screening are of bronze or other non-corrosive material. The unit requires small floor space and less head room than is usually required for other types of self-cleaning screens.

The units are available in any size and capacity from one-half to twenty million gallons per day. The screenings are rejected from the rake teeth with positiveness and certainty. The results obtained by the combination unit are, according to the manufacturer's claims, comparable to those obtained with most types of fine screens.

Municipal Sanitary Service Corporation, 155 East 44th Street, New York City will be pleased to send a descriptive booklet covering this equipment.

WITH THE MANUFACTURERS

Calculating Welding and Cutting Costs

"How to Figure Oxwelding and Cutting Costs." Eight pages. 8½x11. Illustrations and tables. Published by The Linde Air Products Company, New York.

This publication will prove of particular value to managers and supervisors who wish to set up methods of figuring oxwelding and cutting costs best suited to their particular needs. Three different methods for computing material consumption, and the conditions under which each should be used, are presented in tabular form for ready reference. Examples are given to explain each method.

Estimating the cost of blowpipe operation for small jobs of welding, heating, or cutting is greatly simplified by a system of unit costs described. Comparison with slower means of doing the same job can thus be quickly made.

Comparing Seven Kinds of Pumping Equipment

The water filtration plant and pumping station at Highland Park, Ill., described in a paper by Mr. Paul Hansen, has been reprinted by the De Laval Steam Turbine Co., Trenton, N. J., manufacturers of the pumping equipment. An exhaustive comparison was made of the merits of seven different kinds of pumping equipment. The lowest cost of pumping is shown to be a combination of steam turbine pumps and electric motor driven pumps, although for the conditions of this particular plant, involving capacities ranging from 2 to 6 million gallons per day against 220 ft. head, electric driven pumps alone were a close second. The station is located in a high class suburban district where coal handling equipment and chimneys were not desirable, and therefore electric driven pumps were selected. A copy of the reprinted article may be had by writing the De Laval Steam Turbine Co., Trenton, N. J.

U. S. Pipe and Foundry Moves to New Quarters in Kansas City

The Kansas City, Missouri, office of the United States Pipe and Foundry Company has recently moved into new quarters—the new address being as follows:

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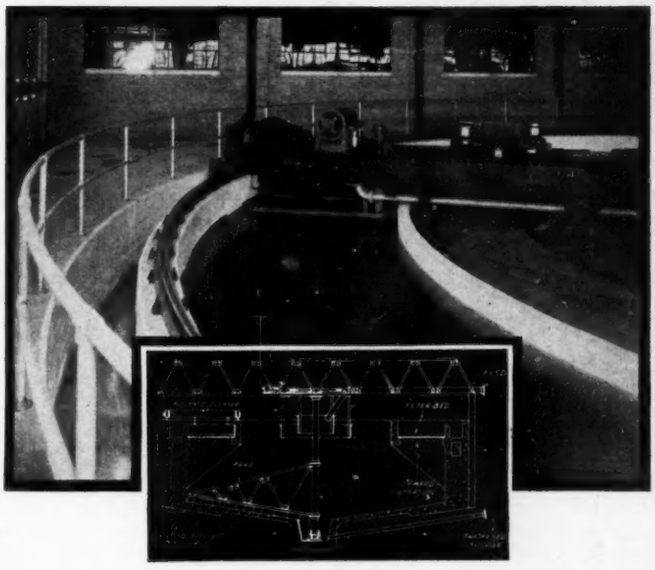

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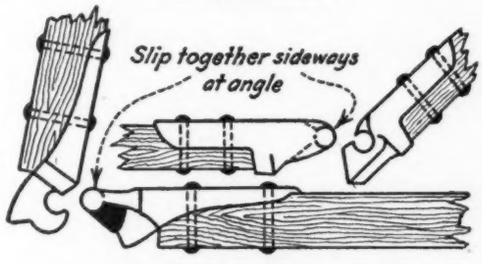

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SANITARY ENGINEER — Twenty years' experience in water purification; past seven and one-half years with State Department of Health in charge of water works supervision. Good experience in swimming pool sanitation. Available immediately. Location immaterial. Address "A. C.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

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SANITARY AND CIVIL ENGINEER, 29, married; B. S. from Iowa State College; M. S. from West Virginia University; registered professional engineer, Iowa; 4 years' practical experience, 2 years research and assistant teaching. Location immaterial. Address "E. T. R.," % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

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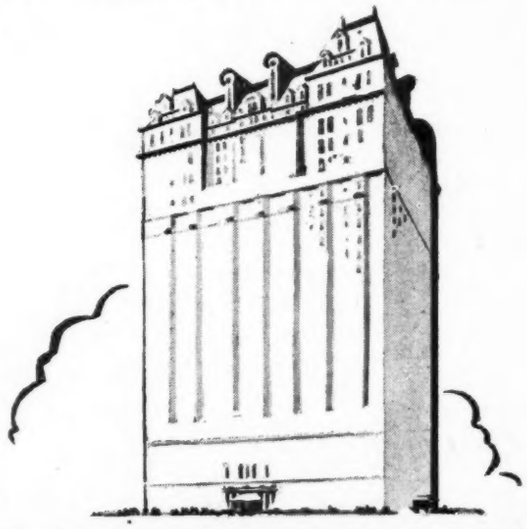

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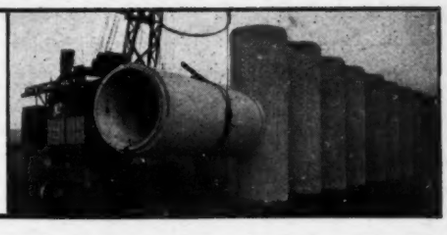

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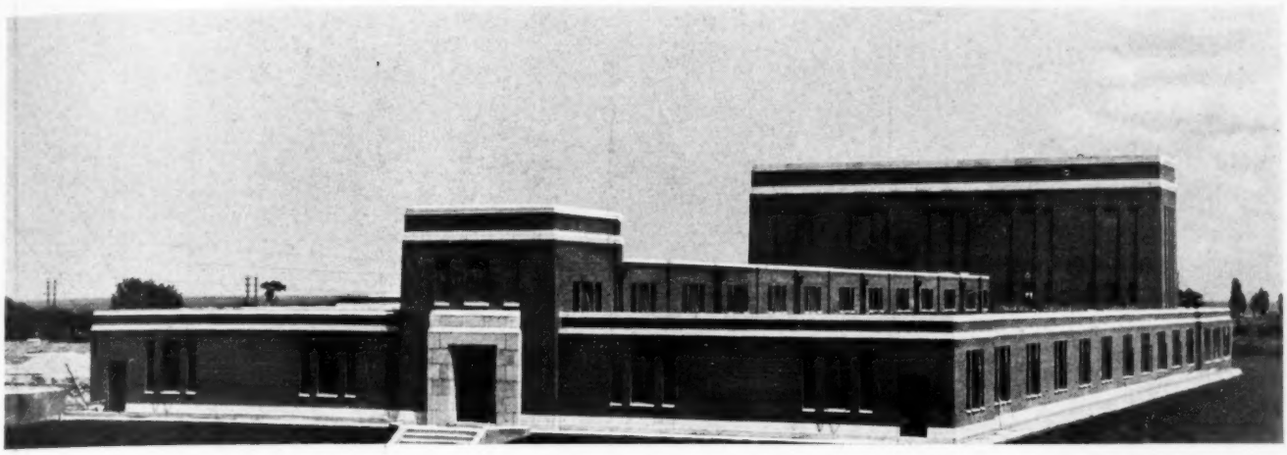
WATER WORKS THRIVE
ON A FLOCCULATED FEED



The Hamilton, Ont. water works employs Turbo Mixers for flash mixing with alum and four Dorrco Duplex Flocculators for flocculation ahead of sedimentation and filtration. The plant was designed by W. L. McFaul, city engineer, and was built by H. W. Yates Construction Co. of Hamilton and Toronto.

Contemporaneous literature on water works practice, appearing concurrently in the technical press, emphasizes the immediate need for a better prepared feed to sedimentation basins and rapid sand filters. The writings of authorities indicate practical unanimity on this vitally important problem of chemical treatment and floc formation.

The optimum condition is, first, a rapid and complete dispersion of the reagent through the water and second, a fairly long mechanical mixing of the treated water to promote the growth of flocs of the desired size and structure.

Water treated in Dorrco Flocculators is subjected to the following mechanical treatment and consequently is ideally conditioned for subsequent processing.

- Building of flocs of uniform size and structure
- Entrapment of fine impurities by circulating flocs
- Return of flocs to feed to form seed and nuclei
- Variation of degree of agitation at will

The results below speak for themselves and show that the ideal conditions mentioned above have been realized in practice.

- A reduction in chemical consumption
- A more quickly settling floc
- A longer filter run
- Less power consumption

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. . Eight months' operation at Richmond, Va., at 30 M.G.D. shows a saving of 4000 lbs. alum per day, twice the former settling rate, 12 per cent longer filter runs and a power consumption of only 6 KWH per M.G.

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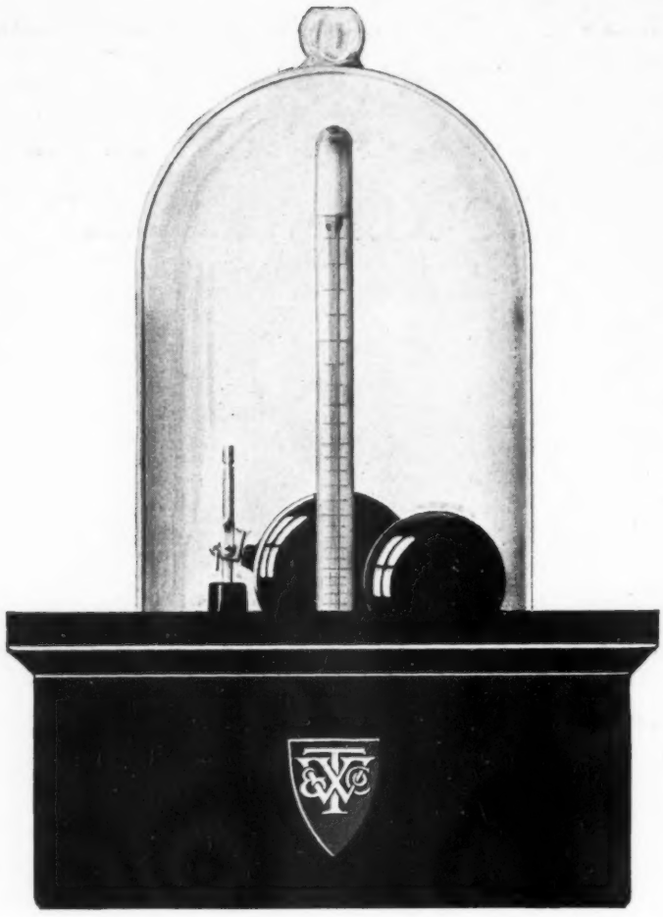

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